Iron and Steel Engineer

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J. F. KELLY, EDITOR

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STATISTICS

ON

A. I. & S. E. E. Iron and Steel Exposition

JUNE 20 - 23, 1932 PITTSBURGH, PA.

ATTENDANCE BY STATES

Alabama, California, Colorado, Connecticut, Delaware, Illinois, Indiana, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Missouri, New Jersey, New York, Ohio, Pennsylvania, Tennessee, Texas, Virginia, West Virginia, Wisconsin

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Steam Engineers
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Purchasing Agents
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Expeditors
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E D I T O R I A L

A. I. & S. E. E. Convention

JUNE 20 - 23, 1932 **PITTSBURGH, PA.**

Four thousand executives and engineers attended the A. I. & S. E. E. Convention and Exposition held June 20-23rd, at Pittsburgh, Pa.

This attendance indicates the interest of the Steel Plants in the developments of apparatus for use in processing and producing Iron and Steel.

When it is taken into consideration that the attendance covered 26 states, 128 cities, 549 plants and the personnel of the men attending covered 55 fields of endeavor, the judgment of the Board of Directors in holding the Convention and Exposition this year was justified and warranted.

TECHNICAL SESSIONS

Twenty-eight engineers presented papers and 142 engineers discussed the major points brought out in these papers. Combustion, Lubrication, Mechanics, Electricity, Safety, Metallurgy and Welding were the principal topics discussed.

The attendance at the sessions averaged close to 250 persons, the greatest attendance being 415 at the Tuesday morning session, which covered Ladle Crane Practices, Control Standarization and Devices Actuated by Light.

The National Committees presented their reports Monday morning which were well received.

ELECTION OF OFFICERS

The election of officers was as follows:

President—J. D. Donovan, Elec. & Mech. Supt., Republic Steel Corporation, Massillon, Ohio.
1st Vice Pres.—W. E. Miller, Elec. Supt., Bethlehem Steel Co., Johnstown, Pa.
2nd Vice Pres.—W. H. Burr, Elec. Supt., Lukens Steel Co., Coatesville, Pa.
Treasurer—J. H. Van Campen, Chief Engineer, Youngstown District, Republic Steel Corporation, Youngstown, Ohio.
Secretary—J. A. Clauss, Chief Engineer, Great Lakes Steel Corp., Ecorse, Mich.
Director at Large—G. R.Carroll, Elec. Supt., Jones & Laughlin Steel Corp., Aliquippa, Pa.
Directors—H. D. Esterly, Elec. Supt., Alan Wood Steel Co., Conshohocken, Pa.
E. C. Marshall, Elec. Supt., Youngstown Sheet & Tube Co., East Chicago, Ind.
R. F. Sanner, Asst. Elec. Engr., Carnegie Steel Company, Duquesne, Pa.
W. H. Gilbert, Asst. to Mech. Engr., Tennessee Coal, Iron and Railroad Co., Birmingham, Ala.
A. D. Adams, Asst. Supt., Spang Chalfant Co., Ambridge, Pa.
P. F. Haberstick, Safety Engineer, Wheeling Steel Corp., Wheeling, W. Va.
A. L. Foell, Chief Engineer, Arthur G. McKee Co., Cleveland, Ohio

MECHANICAL POWER TRANSMISSION

The Mechanical Power Transmission Division presented their views in connection with this subject. While the scope of this Division covers a wide range of subjects, it has been decided to confine this particular Division's work for a time at least, towards the preparation of specifications covering reduction gear drives. The work of this Committee must not be confused with the work of any of the Standardization Committees, as no attempt will be made to standardize this class of equipment.

Following is a tentative program of the Mechanical Power Transmission Division's work for the future:

Power Transmission Studies

Rope	Hydraulic	Worm
Gear	Belt	Screw
Magnetic	Chain	Hydraulic Speed Reducers
Friction	Cam	Vacuum Media
Pneumatic	Eccentric Couplings	

APPRECIATION

The President and Board of Directors of the Association of Iron and Steel Electrical Engineers desire at this time to thank all of the authors who presented papers before the Society at its 28th National Meeting held in Pittsburgh, Pa., June 20-23rd, 1932.

They also desire to thank the Chairmen and Membership of the Electrical, Lubrication, Combustion, Mechanical and Safety Engineering Divisions for their splendid efforts in helping to make the technical sessions such a success.

Their thanks are also extended to the Chairmen and Membership of the General Convention Committee, Iron and Steel Exposition Committee, General Registration Committee, Invitation and Ticket Committee, Monday Evening Informal Reception ception Committee and the Thursday Evening Formal Reception Committee.

The President, Board of Directors and the entire Membership of the Association of Iron and Steel Electrical Engineers desires to extend their sincerest appreciation to the manufacturers who participated in the Iron and Steel Exposition.

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ASSOCIATION
OF
IRON AND STEEL ELECTRICAL ENGINEERS

Control Committee Preliminary Report

by

E. L. UPP,
Chairman and Electrical Superintendent,
National Tube Co., McKeesport, Pa.

This Report Covers
Full Magnetic D. C. Controllers

(a) QUESTIONNAIRE ON POINTS TO BE INCLUDED IN GENERAL SPECIFICATIONS FOR FULL MAGNETIC D. C. CONTROLLERS.

(b) COMMENTS ON PROPOSED SPECIFICATION.

(c) COMMENTS RECEIVED FROM A. I. & S. E. E. COMMITTEE.

(d) MINUTES OF THE A. I. & S. E. E. CONTROL COMMITTEE MEETING, JANUARY 9, 1932.

(e) MINUTES OF THE JOINT MEETING OF THE A. I. & S. E. E. CONTROL COMMITTEE AND NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION COMMITTEE ON CONTROL APPARATUS HELD MARCH 9, 1932.

PRESENTED AT THE TWENTY-EIGHTH CONVENTION OF THE A. I. & S. E. E., PITTSBURGH, PA., JUNE 20 - 23, 1932.

A. I. & S. E. E. Control Committee Report

Questionnaire on Points to be Included in General Specification for Full Magnetic D. C. Controllers

By E. L. UPP
Chairman and Electrical Superintendent,
National Tube Co., McKeesport, Pa.

1. NO. REQUIRED.....

2. H. P.....VOLTAGE.....

3. TYPE — Reversing / Non-Reversing — Plugging / Armature Shunt / Dynamic Braking — Current Limit / Time Limit / Time Current — Acceleration

4. SERVICE

(a) For use with.....H. P.....Rating.....Wound.....R. P. M. Full Load Motor, Driving

.....

(b) Motor will normally be started and stopped.....times per minute, under.....% load.

(c) Operating cycle will be as follows:.....

.....

.....

(d)

(e)

5. CONTACTORS—Each Controller shall have:

(a) .....Directional Contactors of.....amp. cont. / mill duty carrying capacity and.....amp. Interrupting capacity.

(b) Circuit Breaker or Negative Line Contactor of.....amp. cont. / mill duty carrying capacity and.....amp. Interrupting capacity.

(c) .....Plugging Contactor of.....amp. cont. / mill duty carrying capacity and.....amp. Interrupting capacity.

(d) .....Accelerating Contactors of.....amp. cont. / mill duty carrying capacity and.....amp. Interrupting capacity.

(e) ..... Armature Shunt / Dynamic Braking Contactor of.....amp. cont. / mill duty carrying capacity and.....amp. Interrupting capacity.

(f)

(g)

6. INTERLOCKS—There shall be:

(a) Mechanical and Electrical Interlocks between Forward and Reverse Directional Contactors.

(b) Electrical Interlocks to prevent any Directional Contactor from closing unless all accelerating contactors are open.

(c)

(d)

7. RELAYS—There shall be:

(a) Necessary accelerating relays to insure that accelerating contactors will close in proper sequence only and at proper time / current values.

(b) Over current relays in one / both side of the line automatic reset / hand reset (by return of master switch both / one to off position).

(c) Open Field Relays in one / both side of line.

(d) Plugging Relay.....

(e) Vibrating type Accelerating Relay to prevent too rapid shunt field weakening.

(f) Vibrating type Decelerating Relay to prevent too rapid shunt field strengthening.

(g) Low Voltage Relay to provide Low Voltage Release / Low Voltage Protection

(h)

(i)

8. COILS

(a) All coils used on above devices shall be wound for full voltage except in case of relay where this is not practicable and where external resistors are used they shall be plainly marked as to ohmic value and current carrying capacity.

(b) All contactors, relays and other devices shall be plainly marked with Manufacturers size, Type and Form Designation.

(c)

(d)

9. KNIFE SWITCHES—There shall be mounted on Panel in Power Circuit:

(a) .....D. P. Fused / Unfused Knife Switch With / Without field discharge clips and With / Without Locking Device.

(b) .....D. P. Fused / Unfused Knife Switch With / Without Locking Device and connected on Line / Load side of Main Knife Switch for Control Circuit.

(c) Fuses, one in each side of control circuit which shall be connected on Load Side of Main Switch.

(d)

(e)

10. SHUNT FIELD RHEOSTAT—There shall be:

(a) .....Shunt Field Rheostat Sep. Mounted / Mounted on Panel shall not have less than.....points. For use with motor having Max. Field.....amp. Min. Field.....amp.

(b)

(c)

11. MOUNTING

(a) All / Each Contactors, relays and other devices shall be mounted on One Common / Individual .....base of uniform size not less than....."thick.

(b) Panel shall be floor / wall mounted on pipe / angles frame work.

(c) Panels shall be Inches / Mfg. Choice in width and Inches / Mfg. Choice in Height.

(d)

(e)

12. ARRANGEMENT CONNECTIONS—WIRING

(a) Arrangement of devices on panel shall be Mfgs. choice.....

(or specify here if special arrangement is desired.)

.....

.....

.....

(b) All devices shall be back / front connected.

(c) All wiring shall be on back / front of panel.

(d) All terminals and devices shall be marked on back and front of panel.

(e) Terminal Board for control wiring shall be located on back / front of panel along right hand edge, when facing back of panel, 12" clearance from bottom of panel.

(f)

(g)

13. ENCLOSING COVERS—Shall be:

(a) Not Required.

(b) Of Sheet Steel not less than 14 gage with hinged / removable doors in front and hinged / removable doors in rear.

(c) Hinged doors be so arranged as to require not more than 18" clearance to swing full open.

(d) Coated with heavy coating of rust-resisting paint or enamel and Mfgs. Choice / (Purchasers) in color.

(e) Separate cover for resistor not required. / to be furnished.

(f) Separate cover for Shunt Field Rheostat not required. / to be furnished.

(g) Weather proof for outside mounting.....

14. RESISTORS—

(a) Starting, Plugging and Dynamic Braking shall be Iron Grid / Unbreakable Alloy Grid / Wound on Edge

(b) Starting resistor shall be N. E. M. A. Class.....

(c) Plugging resistor shall be.....

(d) Dynamic Braking resistor shall be.....

.....

(e) Resistor shall be Separately Mounted Open / Enclosed

Mounted inside of Panel enclosing case. Above / Below / In rear of Panel.

(f) Shunt Field discharge resistor shall not be required / be furnished

(g) All resistor frames shall be....." Long....." Wide....." High with center lines of mounting holes in top and bottom

of frames....." Long....." Wide.

15. ACCESSORIES—There shall be:

(a) .....Push Button Stations of following type.....

.....

(b) Master Switch to give.....points Forward.....points Reverse. Off point dynamic brake—off point over current and low voltage reset and to be equipped with handle arranged for Vertical / Radial Operation With / Without Spring Return.

(c) Push Buttons, Master Switch and Limit Switches shall be so designed as to open both sides of Control Circuit.

(d) Limit Switches of following type:.....

.....

16. WIRING DIAGRAMS AND DIMENSION SHEETS

(a) Shall be furnished in triplicate with each controller.

(b) Elementary or across the Line Diagram of control and power circuits, resistance table and resistor layout with resistor values shall be furnished and shall be on same sheet as main diagram, separate drawing for dimensions of controller and accessories shall be furnished.

(c) Shall be of such size as will enable easy following of individual wires.

(d) Lines indicating Power circuits shall be at least four times the width of those indicating control circuits.

(e) All wiring and devices shall be shown, as nearly as practicable, in their actual position on the control panel.

(f) The same symbols and markings shall be used on wiring diagrams, which shall be rear view of panel, as are used in marking panel. The symbols used shall be those adapted by and published in "Industrial" Control Standards of NEMA. When any symbol is used that is not shown it shall be so indicated and note appended explaining the meaning of such symbol.

(g) All Control Wires running from panel to Push Buttons, Master Switches, Limit Switches or other separately mounted devices shall be shown as though run in conduit and shall be numbered where they enter and leave conduit.

(h) All drawings to be certified with purchasers order number, Name, Works and when such information has been furnished manufacturer, with name of drive.

17. REPAIR PART SHEETS

(a) Shall be furnished in triplicate listings by part number and name of repair parts for all devices used on these controls.

(b) When duplicate parts are used on different devices whether on these or other controllers they shall bear the same part number or name or shall bear indications that they duplicate the other part and its number and name shall be given.

18. MARKING OF SHIPMENTS

(a) Each individual case, crate or package shall be plainly marked with Manufacturer's name, location and Order number and with Customer's name, works, order number, Item No., H. P. Rating and where such information has been furnished with name of drive on which it is to be used.

19. (a) Bidder to name price and delivery F. O. B. Factory Freight allowed to.....

(b)

(c)

(d)

COMMENTS ON PROPOSED SPECIFICATION

1. NO. REQUIRED.....OK.

2. H. P.....OK VOLTAGE.....OK.

3. TYPE.....OK.

4. SERVICE.....OK.

5. CONTACTORS—Each Controller shall have:

A to C—We believe that one standard rating should be established for contactors, and suggest the following:
"The ampere capacity of a contactor shall be its ampere carrying capacity for eight hours under conditions of free ventilation throughout life of contact tips, and the current which it will continue to carry during any eight-hour period throughout life of contact tips, with any number of makes and breaks without exceeding NEMA temperature limitation and with the operating coil circuit excited at full rated voltage."
This you will note is a modification of section 120-513-A, page 9, "Industrial Control Standards of NEMA", First edition 1929. As written it does not seem to us to be of much value as few contactors will be operated over periods of any given number of hours without interruption and what we are interested in is the current it will carry under operating conditions where the heating effect is a combination of current carrying, rupturing and condition of contacts. With this rating established it should be substituted in the specification in place of mill or continuous duty ratings. A contactor so rated might for instance be listed as 150/100 Amp.
The 150 amp. being its eight-hour capacity without interruption.
The 100 amp. being its eight-hour capacity with frequent interruption.

6. INTERLOCKS—There shall be:

(a) We believe Mechanical Interlocks only are necessary on modern controllers.

(b) We do not believe Electrical Interlocks are necessary between Directional and Accelerating Contactors.

7. RELAYS—There shall be:

(b) We would suggest that over current relays be instantaneous trip in one side of line and inverse time element in other side.

(a) OK.
(c) OK.
(d) OK.
(e) OK.
(f) OK.

8. COILS

(a) OK.
(b) OK.

9. KNIFE SWITCHES

A & B—We do not believe that a Knife Switch in either Power or Control Circuit is necessary. Safety Codes in most Steel Mills prohibit open knife switches making it necessary to install an enclosed Knife Switch or Circuit Breaker ahead of the one in the panel and on the greater portion of modern controllers the devices will not function without current in the power circuit so the advantages of being able to try out the controller by energizing control circuit connected on line side of Main Switch no longer exists. We also believe that a control switch connected ahead of the line switch introduces a certain hazard through likelihood of its being left in with part of the panel alive after main switch has been pulled. We, therefore, recommend no main or control switch and only fuses in both sides of the control circuit. Field discharge clips if required should be provided on external knife switch or circuit breaker or permanent field discharge resistor can be used.

10. SHUNT FIELD RHEOSTAT

(a) We favor separate mounting of shunt field Rheostat with enclosing cover.

11. MOUNTING

(a) We favor one common base but have no objection to this being sectionalized on larger panels, not individual bases, however, and would recommend a panel thickness of 1¼ inches.

(b) We believe that angle frame work is generally preferable.

(c) Where it is necessary to line up panels with existing panels or panels of other make, we believe it would be advantageous to specify height and width to suit manufacturers requirements, but if space is limited width should be specified leaving height to suit Mfgs. Requirements.

12. ARRANGEMENT CONNECTIONS—WIRING

(a) Arrangements of devices should in our opinion be left to Manufacturer unless some local condition requires special arrangement.

(b) We favor back connected devices.

(c) We favor all wiring on back of panel.

(d) Marking on back of panel only.

(e) Terminal Board on back of panel location, OK.

13. ENCLOSING COVERS.

(b) Hinged doors unless space requirements do not permit.
(A-C-D-E-F-G) OK.

14. RESISTORS

(A-B-C-D-F-G) OK.

(e) We believe the resistor should be mounted inside the cabinet the required space is available and proper ventilation can be obtained.

15. ACCESSORIES.

(A-B-D) OK.

(c) We believe that both sides of the control circuit should be opened by Push Button Starter Master Switches and if possible by Limit Switches and Flag Switches in order to avoid false operation caused by control circuit grounds and short circuits. We have not mentioned locking device on master switches and do not think they should be provided.

16. WIRING DIAGRAMS AND DIMENSION SHEETS
(A-B-C-D-E-F-G-H) OK. Dimensions of sheets probably would be specified.

17. REPAIR PART SHEETS
(A-B) We believe each Manufacturer should furnish a sheet on which Control Parts (these parts which are usually carried in stock by the purchaser) are tabulated showing the number of Contactor relays on which the same parts are used. This sheet to be arranged so that new parts can be added when required.

18. MARKING OF SHIPMENTS.
OK.

19.
OK.

November 23, 1931.

COMMENTS ON QUESTIONNAIRE BY ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS SPECIAL CONTROL COMMITTEE

ITEM NO. 1—QUANTITY:

Approved as written:

C. J. Smith, J. R. Barefoot, O. H. Meineke, E. C. Marshall, J. D. Kelvie, W. F. Riggs, J. I. Kaspari, F. H. Kittredge, J. H. Barse, F. D. Egan, J. S. Delaney, E. L. Anderson, H. F. Raab, E. L. Upp

General approval—No comments

M. H. Morgan, Jr., C. T. Phillips, R. S. Hurtt

ITEM NO. 2—RATING:

Approved as written:

C. J. Smith, J. R. Barefoot, O. H. Meineke, E. C. Marshall, J. D. Kelvie, W. F. Riggs, J. I. Kaspari, F. H. Kittredge, J. H. Barse, F. D. Egan, J. S. Delaney, E. L. Anderson, H. F. Raab, E. L. Upp

General approval—No comments

M. H. Morgan, Jr., C. T. Phillips, R. S. Hurtt

ITEM NO. 3—TYPE:

Approved as written:

C. J. Smith, J. D. Kelvie, W. F. Riggs, E. C. Marshall, F. H. Kittredge, C. T. Phillips, J. I. Kaspari, J. S. Delaney, R. S. Hurtt, M. H. Morgan, Jr., E. L. Upp, J. H. Barse, F. D. Egan, O. H. Meineke, E. L. Anderson, H. F. Raab

General approval—No comments

M. H. Morgan, Jr., C. T. Phillips, R. S. Hurtt

Exceptions

J. R. Barefoot—Too general. Separate forms should be used for mill control such as table, screwdown, manipulator, etc., and crane control (especially hoists) as their operating characteristics are different and specifications should be changed accordingly.

ITEM NO. 4—SERVICE:

Approved as written:

C. J. Smith, J. D. Kelvie, O. H. Meineke, E. C. Marshall, F. H. Kittredge, W. F. Riggs, J. I. Kaspari, J. S. Delaney, J. H. Barse, F. D. Egan, E. L. Upp, E. L. Anderson, H. F. Raab

General approval—No comments

C. T. Phillips, R. S. Hurtt

Exceptions

J. R. Barefoot—A-B-C- Nothing under four (4) to provide for operating characteristics of dynamic braking hoist controller.

M. H. Morgan, Jr.—I would recommend adding items to show the exact nature of the drive—such as, approach table, bloom shear, centrifugal pump, etc., another item to give the manufacturer some information about the character of the atmosphere in which the controller will be mounted—such as, hot, moist, dirty and corrosive.

ITEM NO. 5—CONTACTORS:

Approved as written:

J. I. Kaspari, J. D. Kelvie, W. F. Riggs, F. D. Egan, (C-D-E), O. H. Meineke (B-C-D-E)

General approval—No comments

J. S. Delaney, C. T. Phillips, R. S. Hurtt

Exceptions

C. J. Smith—A to E—We believe that one standard rating should be established for contactors. Whether this rating be a continuous or intermittent rating would make little difference as long as it was standard with all manufacturers and gave a true indication of the capacity of the contactor under one specific condition.

E. C. Marshall—O.K., but believe some statement defining "continuous" and "mill" duty should be made, either by reference to some recognized standard, such as NEMA, AIEE or by a statement in a foot note under this item.

F. D. Egan—A—We prefer continuous rating on contactors. Blow out coils on contactors for reversing service should be most effective 200 to 300% load rating of motor.

B—Circuit Breaker or negative line contactor to be on opposite side of line from reversing contactors, all lines to the motor should be dead with master controller in "off" position. Shunt fields may be hot but resistance should be inserted in field circuit to prevent overheating of shunt fields when motor is not in motion.

F—Dynamic breaking in steps.

H. F. Raab—The ampere capacity of a contactor shall be its ampere carrying capacity for eight hours under conditions of free ventilation throughout life of contact tips, and the current which it will continue to carry during any eight hour period throughout life of contact tips, with any number of makes and breaks without exceeding NEMA temperature limitation and with the operating coil circuit excited at full rated voltage.

J. R. Barefoot—Too much detail. This could be covered by three statements:

1. "Controller to provide—points of acceleration".
2. "Bidders shall state number and mill (or continuous) current rating of contactors they propose to furnish".
3. "A sufficient number of contactors shall be furnished and controller arranged so that motor is disconnected from both sides of the line in the 'off' position".

Every steel mill engineer knows, or should know, the characteristics of the various sized contactors

of the different manufacturers and a statement of the size contactor should suffice.

O. H. Meineke—The ampere capacity shall be based on its carrying capacity for eight hours continuous duty and on an ampere capacity for eight hours based on a definite number of interruptions per minute. All other points O. K.

M. H. Morgan, Jr.—I approve of your proposed method of rating of contactors, but I believe it would be an improvement to specify in the rating the exact number of (breaks) and the current to be interrupted in order that in testing any given contactor, it will be possible to duplicate test conditions exactly.

J. H. Barse—A to E—We believe that one standard rating should be established for contactors and suggest the following:

The ampere capacity of a contactor shall be its maximum ampere carrying capacity for eight hours under the following conditions:

A—Free ventilation throughout the life of its contact tips.

B—Without exceeding N.E.M.A. temperature limitations.

C—With the operating coil circuit excited at full rated voltage.

D—With.....equally spaced breaks per minute, and current on and off equal intervals.

E—With circuit inductance equivalent to that of maximum sized mill type motor with which contactor would be used.

The writer agrees with the comment of Mr. Upp that what we are most interested in concerning contactor carrying capacity is the current it will carry under operating conditions, where the heating effect is a combination of current carrying, rupturing and condition of contacts. We feel, however, that a limit should be made on the number of ruptures per minute. Just what this number could be, should be determined in a conference with the electrical manufacturers. We also believe that this rating should be the only one used for steel mill quotations. The manufacturer, of course, can give the contactor larger rating for other industrial applications.

E. L. Anderson—A—C—Main circuit contactors should all be the same size.

B—Circuit breaker or Positive-Negative Line Contactor, etc.

F. H. Kittredge—A to C—We should try to get all control manufacturers to agree on one standard rating for contactors. We should specify standard size contactors for a certain horsepower range of motors.

E. L. Upp—A to C—We believe that one standard rating should be established for contactors, and suggest the following:

"The ampere capacity of a contactor shall be its ampere carrying capacity for eight hours under conditions of free ventilation throughout life of contact tips, and the current which it will continue to carry during any eight hour period throughout life of contact tips, with any number of makes and breaks without exceeding NEMA temperature limitation and with the operating coil circuit excited at full rated voltage".

This you will note is a modification of section 120-513-A, page 9, Industrial Control Standards of NEMA, First edition 1929. As written it does not seem to us to be much value as few contactors will be operated over periods of any given number of hours without interruption and what we are interested in is the current it will carry under operating conditions where the heating effect is a combination of current carrying, rupturing and condition of contacts. With this rating established it should be substituted in the specification in place of mill or continuous duty ratings. A contactor so rated might for instance be listed as 150/100 amp.

The 150 amp. being its eight hour capacity without interruption.

The 100 amp. being its eight hour capacity with frequent interruption.

ITEM NO. 6—INTERLOCKS:

Approved as written:

C. J. Smith (B) F. D. Egan, (B) O. H. Meineke,(A)
E. C. Marshall H. F. Raab C. T. Phillips
J. I. Kaspari, (B) J. D. Kelvie, (A) E.L.Anderson,(B)
M. H. Morgan, Jr. F. H. Kittredge

General approval—No comments

C. T. Phillips R. S. Hurtt

Exceptions

C. J. Smith—A—We believe that mechanical interlocks only are necessary between a forward and reverse directional contactors.

J. I. Kaspari—A—Mechanical Interlocks between Forward and Reverse Directional Contactors.

F. D. Egan—A—We do not consider electrical interlocks necessary in majority of cases. This should be left optional.

H. F. Raab—A—We believe Mechanical Interlocks only are necessary on modern controllers.

B—We do not believe Electrical Interlocks are necessary between Directional and Accelerating Contactors.

J. R. Barefoot—Electrical interlocks not deemed necessary as they add further complications.

O. H. Meineke—B—Not necessary.

W. F. Riggs—A—Mechanical Interlocks between "Forward" and "Reverse" Directional Contactors.

B—No Electrical Interlock between Directional Contactors and Accelerating Contactors.

J. D. Kelvie—B—Unnecessary.

J. S. Delaney—A—Mechanical Interlocks between "Forward" and "Reverse" Directional Contactors.

J. H. Barse—A—We believe Mechanical Interlocks only are necessary on modern controllers.

B—We do not believe Electrical Interlocks are necessary between Directional and Accelerating Contactors.

E. L. Anderson—A—No Electrical Interlocks required when Mechanical Interlocked.

E. L. Upp—A—We believe Mechanical Interlocks only are necessary on modern controllers.

B—We do not believe Electrical Interlocks are

necessary between Directional and Accelerating Contactors.

ITEM NO. 7—RELAYS:

Approved as written:

C. J. Smith (A-C-D-E-F)
J. I. Kaspari (A-D-E-F-B)
H. F. Raab (A-C-D-E-F-G)
J. D. Kelvie (A-C-D-E-F-G)
F. H. Kittredge (A-D-E-F-G)
J. S. Delaney (A-D-E-F)
E. L. Upp (A-C-D-E-F-G)
O. H. Meineke (A-C-D-E-F)
J. H. Barse (A-C-D-E-F-G)
E. L. Anderson (A-D-E-F-G)
F. D. Egan
J. R. Barefoot
W. F. Riggs
C. T. Phillips
R. S. Hurtt

General approvals—No comments:

M. H. Morgan, Jr. C. T. Phillips R. S. Hurtt

Exceptions

C. J. Smith—B—O. K. except we believe that provision should be made for stating type of over current relays such as instantaneous trip, inverse time element or thermal.

E. C. Marshall—O. K., but would add note requesting a statement as to range of time delay adjustments of the accelerating relays. It is not infrequent that too little consideration is given loads of large mass, such as ore bridge trolleys, and a review of the time of each relay would serve as a caution to effect adequate time delays.

J. I. Kaspari—C—Open Field Relays in one side of line.

G—Low Voltage Relay to provide Low Voltage Protection.

H. F. Raab—B—We would suggest that over current relays be instantaneous trip in one side of line and inverse time element in other side.

O. H. Meineke—B—Instantaneous trip in one side of line inverse time element in other side.

G—To provide low voltage protection.

J. D. Kelvie—B—O.K., as indicated but provisions should be made for omitting overload protection entirely if not wanted.

G—O. K., as indicated but provisions should be made for omitting voltage protection entirely if not wanted.

J. S. Delaney—B—Over current relays in both sides of line one (1) Inst., one (1) Inverse Time Element.

C—Open Field Relays in one side of line.

G—Low Voltage Relay to provide Low Voltage Release.

F. H. Kittredge—B and C—There should be relays in both sides of line, one instantaneous and one inverse time.

J. H. Barse—B—We would suggest that over current relays be instantaneous trip in one side of line and inverse time element in the other.

E. L. Anderson—C—Open Field Relays in Positive—Negative—Both sides of line.

E. L. Upp—B—We would suggest that over current relays be instantaneous trip in one side of line and inverse time element in other side.

ITEM NO. 8—COILS—

Approved as written:

C. J. Smith
J. I. Kaspari
H. F. Raab
J. R. Barefoot
E. C. Marshall (B)
J. D. Kelvie (B)
F. H. Kittredge
J. S. Delaney
E. L. Upp
O. H. Meineke
W. F. Riggs
J. H. Barse
E. L. Anderson

General approval—No comments

C. T. Phillips R. S. Hurtt M. H. Morgan, Jr.

Exceptions

C. E. Marshall—A—All coils used on above devices should be wound for full voltage except in case of relay where this is not practicable. Where resistors are used they should be plainly marked as to ohmic value and continuous current carrying capacity.

F. D. Egan—A—Where coils are not mill voltage contactor or device should have voltage stamped on name plate and "external resistance" designated, in addition to ohmic value and current carrying capacity stamped on resistor. External resistor to be mounted on front of panel directly alongside device it is used with.

J. D. Kelvie—A—O.K., except voltage to be marked on each coil in addition to style number.

ITEM NO. 9—KNIFE SWITCHES:

Approved as written:

F. D. Egan (A-B)
W. F. Riggs (A-B)
M. H. Morgan, Jr.
F. H. Kittredge (C)
J. S. Delaney (C)
C. J. Smith
E. C. Marshall
J. I. Kaspari
H. F. Raab
J. D. Kelvie
L. M. Ripple
J. H. Barse
E. L. Upp (C)

General approval—No comments

O. H. Meineke (C) J. S. Delaney (A-B) R. S. Hurtt
W. F. Riggs (C) C. T. Phillips

Exceptions

F. D. Egan—C—Fuses only satisfactory on small size motor control circuits which control operations that will not hold up mill.

J. R. Barefoot—Main line unfused Knife Switch with locking clips and fused control which connected to line side.

O. H. Meineke—A—D.P. unfused main line switch with field discharge resistor were necessary, furnished with locking device.

B—D.P. fused control switch connected on line side of main line switch.

E. L. Anderson—A-B-C—On panels mounted within enclosing covers, knife switches are not recommended in either the main or control circuits. The control circuits should, however, be provided with a suitable 30 or 60 ampere cartridge fuse in each side of line.

On open panels as used on a group of mill auxiliary motors and where panels are located in the mill sub-station or other suitable control house it is recommended that a non-fused 2 pole knife switch be provided in the main circuit and a 2 pole fused knife switch be furnished in the control circuit. This latter switch to be connected ahead of main switch, as we believe it is an advantage to be able to check control circuits with main switch open, especially

where the group of panels is provided with a spare board.

On cranes where a protective panel is mounted in cage and control panels are mounted on bridge girder or trolley, the panels should be furnished without knife switches or fuses in control circuit.

E. L. Upp—We do not believe that a Knife Switch in either Power or Control Circuit is necessary. Safety Codes in most Steel Mills prohibit open knife switches making it necessary to install an enclosed Knife Switch or Circuit Breaker ahead of the one in the panel and on the greater portion of modern controllers the devices will not function without current in the power circuit so the advantages of being able to try out the controller by energizing control circuit connected on line side of Main Switch no longer exists. We also believe that a control switch connected ahead of the line switch introduces a certain hazard through likelihood of its being left in with part of the panel alive after main switch has been pulled. We, therefore, recommend no main or control switch and only fuses in both sides of the control circuit. Field discharge clips if required should be provided on external knife switch or circuit breaker or permanent field discharge resistor can be used.

ITEM NO. 10—SHUNT FIELD RHEOSTAT:

Approved as written:

C. J. Smith, H. F. Raab, E. L. Anderson, E. C. Marshall, J. R. Barefoot

General approval—No comments

C. T. Phillips, R. S. Hurtt

Exceptions

E. L. Upp—We favor separate mounting of shunt field Rheostat with enclosing cover.

J. I. Kaspari—One shunt Field Rheostat Separately Mounted shall have not less than..... points. For use with motor having Max. Field..... Amp. Min. Field ..... Amp.

F. D. Egan—Shunt Field Rheostats located back of the panel shall not prevent free access to back of board wiring.

O. H. Meineke—Shunt Field Rheostat separately mounted and totally enclosed.

W. F. Riggs—Separate mounting of shunt field rheostat with enclosing cover.

M. H. Morgan, Jr.—I would add an item to permit Purchaser to specify a full field interlock on rheostat where desired.

J. D. Kelvie—Shunt Feld Rheostat O.K. and should show voltage.

L. M. Ripple—Separate mounting with enclosing cover.

J. S. Delaney—Shunt Field Rheostat Sep. Mounted shall have not less than——points. For use with motor having Max. Field——Amp. Min. Field——Amp.

J. H. Barse—We favor separate mounting of shunt field rheostat with enclosing cover.

ITEM NO. 11—MOUNTING:

Approved as written:

E. L. Upp (B&C), C. J. Smith, E. C. Marshall, J. I. Kaspari (B), H. F. Raab, J. R. Barefoot (B&C), W. F. Riggs (C), J. D. Kelvie, F. H. Kittredge (B&C), J. S. Delaney (C), J. H. Barse (C), E. L. Anderson (B&C)

General approval—No comments

C. T. Phillips, R. S. Hurtt

Exceptions

E. L. Upp—A—We favor one common base but have no objections to this being sectionalized on larger panels, not individual bases, however, and would recommend a panel thickness of 1¼ inches.

J. I. Kaspari — A — Recommend sectionalizing boards on all Contactors, relays and other devices shall be mounted on one common size. Some such scheme as directional contactors on one (1) piece, Switches and Relays on another, Accelerating contactors on a third.

C—Panels shall be Manufacturers choice in width and Manufacturers choice in height unless specified by Purchaser due to matching with existing equipment on space requirements.

F. D. Egan—A—Slate only for voltage over 110.

B & C—Panels to butt against each other to present a continuous surface of slate no open space between panels. Slate to be carried to floor in stationary location. May be open in cranes. All panels to be 90" high and sections to line and match up to meet sections of station controls adjacent to them.

J. R. Barefoot—A—Separate mounting or at least three sections of panel to prevent necessity of scrapping entire panel in case of breakage of a part, also for case of replacement of parts.

O. H. Meineke—A—Individual base mounting is convenient for replacement for changing control to suit changing operating conditions. Blanks can be installed to be replaced with devices when found necessary.

B—Floor mounting on angle frame work, bottom of slate to be 12" from floor.

C—Standard light is desirable.

W. F. Riggs—A—Common base with a thickness of 1¼".

B—Frame work of angles.

M. H. Morgan, Jr.—A-B-C—I would add an item to permit Purchaser to specify the material and finish of panels where desired.

L. M. Ripple—A—Individual bases 1¼" thick.

B—Angle frame.

C—Manufacturers choice except in special cases.

D—Slate panels rather than composition preferred.

F. H. Kittredge—A—Composition Panels rather than Slate preferred.

J. S. Delaney—A—Each Contactor, relay or other devices shall be mounted on Individual.....base of uniform size less than....." thick.

B—Panel shall be floor mounted on angle frame work.

J. H. Barse—A—We favor one common base of ebony-asbestos but have no objection to this being sectionalized on larger panels into two parts, not individual bases however, and would recommend a panel thickness of 1¼".

B—We believe that angle iron frame work is preferable.

E. L. Anderson (E. L. Upp)—A—We favor one common base but have no objection to this being sectionalized on larger panels, not individual bases, however, and would recommend a panel thickness of 1¼ inches.

ITEM NO. 12—ARRANGEMENT CONNECTIONS—WIRING

Approved as written:

E. L. Upp (A-B-C-D)
C. J. Smith (B-C-D)
E. C. Marshall
J. I. Kaspari
F. D. Egan (B-C-D)
H. F. Raab (A)
J. R. Barefoot (A-D)
O. H. Meineke (A-D)
W. F. Riggs (A-D)
J. D. Kelvie (A-B-C-D)
F. H. Kittredge (A-D)
E. L. Anderson (A-B-C)

General Approval—No Comments

H. F. Raab (A) C. T. Phillips R. S. Hurtt

Exceptions

E. L. Upp—E—Terminal board on back of panel location, O.K.

C. J. Smith—A—O.K. except add that all devices shall be so spaced that anyone may be disassembled and repaired without interference with adjacent devices on the same panel or adjoining panels.

E—It would be desirable to allow blank space for giving the location of the terminal board in special cases where this proposed standard location is unsuitable.

F. D. Egan—A—Manufacturers choice approved by purchaser.

E—Terminal board with connections going to machines or conduit preferred across the back of panel 12" high gives better distribution of cables going out.

H. F. Raab—B—We favor back connected devices.

C—We favor all wiring on back of panel.

D—Marking on back of panel. Contactors and Relays should be marked on front of panel.

J. R. Barefoot—B—Back connected.

C—Back of panel.

E—Back of panel.

B, C & E—Superfluous as this is standard with all manufacturers.

O. H. Meineke—B—All devices shall be back connected.

C—All wiring shall be on back of panel.

E—Terminal board to be located in back of panel, in center of panel, 12" from floor.

W. F. Riggs—B—Back connected device.

C—Wiring shall be on back of panel.

E—Terminal board for Control Wiring to be located on back of panel.

M. H. Morgan, Jr.—A-B-C-D-E—I believe it would be possible to arrive at a standard location for incoming line terminals which would simplify mounting and wiring. I prefer all wiring and marking on back of panel and back connected devices.

J. D. Kelvie—E—Various locations should be shown.

L. M. Ripple—A—Manufacturers choice.

B—Back connected.

C—Back of panel.

D—Marking on back for terminals and devices and on front for devices.

E—Terminal back of panel.

J. S. Delaney—A—Arrangement of devices on panel shall be Manufacturers choice.

B—All devices shall be back connected.

C—All wiring shall be on back of panel.

D—All terminals and devices shall be marked on back.

E—Terminal board for control wiring shall be located on back of panel along right hand edge, when facing back of panel, 12" clearance from bottom of panel.

F. A. Snyder (J. H. Barse)—A—Arrangements of devices should, in our opinion be left to Manufacturer unless some local condition requires special arrangement. In general, we believe, accelerators should be at the top.

B—We do not know of any modern equipment having front connected devices.

C—We favor all wiring on the back of panel.

D—We favor marking all terminal numbers on back of panel, only, but device numbers should be marked on front and back of panel with stencils.

E—Terminal board on back of panel, location O.K.

F—We should insist that all manufacturers shall make their line of steel mill controllers with uniform height of panel and uniform distance from floor to bottom edge of panel, taking care of increasing area needed for larger panels by increasing width of panels.

E. L. Anderson—D—Terminal marking should be on rear of panel. Devices should be marked on front and rear of panel.

E—Terminal board on back of panel location, O.K.

ITEM NO. 13—ENCLOSING COVERS

Approved as written:

J. D. Kelvie (A-C-D-E-F-G)
L. M. Ripple (A-C-D-E-G)
F. A. Snyder-J. H. Barse (A-C-D-E-F-G)
H. F. Raab (A-C-D-E-F-G)
J. R. Barefoot
O. H. Meineke (C-D-E-F-G)
W. F. Riggs (A-C-D-E-F-G)
F. H. Kittredge
J. S. Delaney (C-G)
E. L. Anderson
E. L. Upp
C. J. Smith
E. C. Marshall
F. D. Egan

General Approval—No Comments

C. T. Phillips R. S. Hurtt

Exceptions

J. I. Kaspari—A-B-C-D-E-F-G—Recommends that the entire Item be omitted.

O. H. Meineke—A—Enclosing covers required.

B—Hinged doors preferred.

W. F. Riggs—B—Hinged doors.

M. H. Morgan, Jr.—I would add an item covering dust-tight or ventilated enclosing cases.

J. D. Kelvie—B—O.K. but should be rust resisting sheet steel.

L. M. Ripple—B—Hinged doors.

F—Covered by Iem 10-A. (Separate mounting with enclosing cover).

J. S. Delaney—A—Arrangement of devices on panel shall be Manufacturer's choice.

B—All devices shall be back connected.

D—All terminals and devices shall be marked on back.

E—Terminal Board for control wiring shall be located on back of panel along right hand edge, when facing back of panel, 12" clearance from bottom of panel.

F. A. Snyder (J. H. Barse)—B—Hinged doors in front and removable covers in rear preferred.

ITEM NO. 14—RESISTORS

Approved as written:

E. L. Upp (A-B-C-D-F-G)
J. I. Kaspari (A-B-C-D-F-G)
H. F. Raab (A-B-C-D-F-G)
W. F. Riggs (A-B-C-D-F-G)
F. H. Kittredge (A-B-C-D-E-F)
E. L. Anderson (A-B-C-D-F-G)
E. C. Marshall
F. D. Egan
J. D. Kelvie
L. M. Ripple
C. J. Smith (A-E-F)
J. R. Barefoot (A-E-F-G)
O. H. Meineke (B-C-D-F)
J. S. Delaney (B-C-D)
F. A. Snyder-J. H. Barse (A-B-C-D-E-F)

General Approval—No Comments

H. F. Raab (A-B-C-D-F-G)
R. S. Hurtt
C. T. Phillips
M. H. Morgan, Jr.

Exceptions

E. L. Upp—E—We believe the resistor should be mounted inside of the cabinet if the required space is available and proper ventilation can be obtained.

C. J. Smith—B-C-D—We believe that resistors should be unit type boxes of standardized ratings with each box clearly marked to show ohmic value and current carrying capacity. All boxes to be "A" connected, eliminating the B, C & D connected boxes.

G—Practically all manufacturers have their own standard size frames which are not interchangeable with other makes. Some effort should be made to standardize the size frames so that all makes will be interchangeable.

J. I. Kaspari—E—Resistor shall be separately mounted and open.

J. R. Barefoot—B-C-D—Superfluous.

H—Resistor terminals shall be mounted with metal tags stamped with markings to correspond with wiring diagram.

O. H. Meineke—A—Resistors shall be wound on edge.

E—Resistor shall be mounted inside of enclosing case above and in rear of panel.

G—All resistors shall be of standard length, width and height with standard bolt centers.

W. F. Riggs—E—Resistors shall be mounted inside of panel enclosing case.

J. S. Delaney—A—Starting, Plugging and Dynamic Braking shall be unbreakable and Alloy Grid.

E—Resistor shall be separately mounted and open.

F—Shunt Field discharge resistor shall be furnished.

F—All resistor frames shall be manufacturers standard with center lines of mounting holes in top and bottom of frames..... " Long..... " Wide.

F. A. Snyder (J.H. Barse)—G—Do not believe we can now specify dimensions of resistors. Believe this can be worked out with manufacturers.

E. L. Anderson—E—We believe the resistor should be mounted inside the cabinet if the required space is available and proper ventilation can be obtained.

ITEM NO. 15—ACCESSORIES

Approved as written:

E. L. Upp (A-B-D)
C. J. Smith (A-B-D)
E. C. Marshall
J. I. Kaspari (A-B-D)
F. D. Egan
H. F. Raab (A-B-D)
J. R. Barefoot (A-B-D)
O H. Meineke (A-B-D)
W. F. Riggs
J. D. Kelvie (A-B-D)
L. M. Ripple (A-B-D)
F. H. Kittredge (A-B-D)
F. A. Snyder-J. H. Barse
E. L. Anderson (A-B-D)

General Approval—No Comments

C. T. Phillips
R. S. Hurtt
M. H. Morgan, Jr.

Exceptions

E. L. Upp—C—We believe that both sides of the control circuit should be opened by Push Button Starter Master Switches and if possible by Limit Switches and Flag Switches in order to avoid false operation caused by control circuit grounds and short circuits. We have not mentioned locking devices on master switches and do not think they should be provided.

C. J. Smith—C—We believe that provision should be made to allow for customers choice as to taking both sides of the control circuit through push buttons, master switches and limit switches.

J. I. Kaspari—C—Push buttons, master switch and limit switches shall be so designed as to open both sides of control circuit.

H. F. Raab—C—We believe that both sides of the control circuit should be open by push button starter master switches and if possible by limit switches and flag switches in order to avoid false operation caused by control circuit grounds and short circuits. We have not mentioned locking devices or master switches and do not think they should be provided.

J. R. Barefoot—C—Not required.

O. H. Meineke—C—Push buttons and master switches would become larger in size if both sides of line will have to be opened. Limit switches should be designed to open both sides of line.

J. D. Kelvie—C—Should be optional with one or both sides of line.

L. M. Ripple—C—Push buttons, master switches

and limit switches to open one side of control circuit except in special cases.

F. H. Kittredge—C—Master switch, push buttons, etc., should not be made to open on both sides of control circuit.

J. S. Delaney—C—Push buttons, master switch and limit switches shall be so designed as to open one side of control circuit.

E. L. Anderson—C—We believe that both sides of the control circuit should be opened by push button starter master switches and if possible by limit switches and flag switches in order to avoid false operation caused by control circuit grounds and short circuits. We have not mentioned locking device on master switches and do not think they should be provided.

ITEM NO. 16—WIRING DIAGRAMS—DIMENSION SHEETS

Approved as written:

E. L. Upp
C. J. Smith (B-C-D-E-F-G-H)
E. C. Marshall
J. I. Kaspari (A-B-C-E-F-G-H)
F. D. Egan (G-H)
H. F. Raab
J. R. Barefoot (A)
O. H. Meineke
W. F. Riggs
J. D. Kelvie
L. M. Ripple
F. H. Kittredge (A-B-C-D-E-F-H)
J. S. Delaney
R. S. Hurtt
F. A. Snyder-J. H. Barse (A-B-C-D-E-F-H)
E. L. Anderson (A-B-D-E-F-G-H)

General Approval—No Comments

J. I. Kaspari (A-B-C-E-F-G-H)
F. D. Egan (G-H)
M. H. Morgan, Jr.
C. T. Phillips

Exceptions

C. J. Smith—A—Triplicate copies of certified wiring diagrams and dimensions sheets should be mailed separately as soon as possible. One copy of wiring diagram and instruction sheet should be furnished with, and attached to each controller.

F. D. Egan—A—Brown positive prints as well as blue print.

B—Resistor value to be given in ohms and carrying capacity sequence chart of relay operations and contactors to be shown.

F—All connection studs designated clearly by letter and number on back of panel.

J. R. Barefoot—B to H—These items seem to be specifications for wiring diagrams. Standardization of wiring diagrams, while a part of the program of this Committee, should be undertaken separately and the specifications for wiring diagrams need not be incorporated in the controller specifications.

F. A. Snyder (J. H. Barse)—G—All control wires running from panel to push buttons, master switches, limit switches or other separately mounted devices, shall not be shown as running in conduit, but each wire shall be shown by a separate line. We do not favor the practice of showing wires as running in conduit, because the manufacturer at least half of the time does not group the wires as we do in our conduit schedule. The manufacturer frequently shows brake resistance located at the brake instead of at the panel where it belongs. Another common difference is in showing conduit runs between a master switch, a limit switch, and the control panel. In most cases the manufacturer will show a few wires in a conduit running between the master switch and limit switch. It simplifies the conduit layout, however, and is more economical to omit this conduit, run all the wires back to control panel and make the interconnection between the limit and master switches at that point. If you so specify on your conduit schedule, and the manufacturer's wiring diagram does not agree, your field electrician will be confused by the different methods of routing the wires. We, therefore, favor omitting any grouping of wires in a "so-called" conduit by the manufacturer.

E. L. Anderson—C—Size and form of diagrams should be made standard. Dimensions as may be agreed upon with control manufacturers. Would suggest about 3 sizes to cover all requirements.

ITEM NO. 17—REPAIR PART SHEETS

Approved as written:

E. L. Upp
C. J. Smith
E. C. Marshall
J. I. Kaspari (A)
F. D. Egan
J. R. Barefoot
O. H. Meineke
W. F. Riggs
J. D. Kelvie
L. M. Ripple
F. H. Kittredge
J. S. Delaney
F. A. Snyder-J. H. Barse
E. L. Anderson

General Approval—No Comments

J. I. Kaspari (A)
M. H. Morgan, Jr.
C. T. Phillips
R. S. Hurtt

Exceptions

H. F. Raab—A-B—We believe each Manufacturer should furnish a sheet on which Control Parts (these parts which are usually carried in stock by the purchaser) are tabulated showing the number of Contactor Relays on which the same parts is used. This sheet to be arranged so that new parts can be added when required.

ITEM NO. 18—MARKING OF SHIPMENT

Approved as written:

E. L. Upp
E. C. Marshall
J. I. Kaspari
H. F. Raab
J. R. Barefoot
O. H. Meineke
W. F. Riggs
J. D. Kelvie
L. M. Ripple
F. H. Kittredge
J. S. Delaney
F. A. Snyder-J. H. Barse
E. L. Anderson

General Approval—No Comments

R. S. Hurtt
C. T. Phillips
M. H. Morgan, Jr.

Exceptions

C. J. Smith—O.K. except add that each piece of apparatus shall be tagged with customers order number, drive, H.P., etc.

F. D. Egan—Shipments of slate panels over 40" wide should be built for provision for knocking down and shipping panels not over 40" to 48" wide for ease in handling.

Minutes of the A. I. & S. E. E. Control Committee Meeting, Jan. 9, 1932

The following is a condensed report of Special Control Committee Meeting held in Parlor C, Seventeenth floor, William Penn Hotel, Pittsburgh, Pa., 2:30 P. M. Saturday, January 9, 1932.

Present:

J. H. Barse, American Steel & Wire Co., Cleveland, Ohio.

H. F. Raab, Bethlehem Steel Company, Johnstown, Pa.

R. S. Hurtt, Pittsburgh Crucible Steel Co., Midland, Pa.

M. H. Morgan, Jr., Carnegie Steel Co., Braddock, Pa.

R. F. Sanner, Carnegie Steel Co., Duquesne, Pa.

J. R. Barefoot, Carnegie Steel Co., Munhall, Pa.

O. H. Meineke, Spang, Chalfant Co., Ambridge, Pa.

E. L. Upp, National Tube Company, McKeesport, Pa.

W. E. Waldron, National Tube Company, McKeesport, Pa.

Mr. Waldron read comments received to date on various items of Control Questionnaire and informal discussion was held on each item by members present with the following results:

Item #1—Quantity—Unanimous agreement as written.

Item #2—Rating—Unanimous agreement as written.

Item #3—Type—Unanimous agreement as written.

Item #4—Service—Unanimously agreed that provision should be made for stating nature of surrounding atmosphere where control is to be installed, such as presence of acid fumes, moisture, unusual dirt conditions, heat, etc.

Item #5—Contactors—After considerable discussion it was unanimously agreed that it would be advisable to arrange meeting with representatives of Control Manufacturers individually or, if possible, with a Committee appointed by them to represent all Control Manufacturers, and arrange with them—

(a)—some standard method of rating contactors.

(b)—standard sizes of contactors.

(c)—standard number of accelerating points for various H.P. controllers.

The Chairman was at this time authorized to appoint a sub-committee to meet with the control manufacturers' committee and settle with them these and other points that might arise and to draw up a revised specification for submission to membership when all points have been agreed upon.

Item #6—Interlocks—Majority opinion was that mechanical interlocks between reverse switches only would be required and that electrical interlock between reverse switches and accelerating switches were unnecessary. It was decided that this should be made standard and that if electrical interlocks were required they would be special and this requirement stated by purchaser.

Item #7—Relays—Majority opinions favored—

Over current relays both sides of line automatically reset by return of master to off position—one to be instantaneous—one inverse time element.

Open field relay both sides of line.

Accelerating and decelerating relays to be furnished when required, but the type will not be specified.

Full field relay to be added.

Item D—Omit reference to plugging relay.

Item G to read—Voltage relay to provide under voltage protection. If other than above required, to be special and specified by purchaser.

Item #8—Coils—Unanimously agreed that "Full Voltage" coils should stand 15% over voltage continuously and to operate on 20% under voltage.

Item #9—Knife Switches—There was considerable discussion on this item resulting in majority opinions that there should be main line knife switch and control switches on panel but that as there was a recognized hazard in opening under load the type of switches ordinarily furnished on control panels that effort should be made to reach an agreement with control manufacturers to furnish an arc rupturing type of switch or circuit breaker either to be mounted back of board and operated from front or outside of enclosing cover or an enclosed type safety switch. Switches to be provided with device for applying locks and field discharge clips where necessary. Control Switch to be connected on line sides of main switch.

Item #10—Shunt Field Rheostat — Unanimous opinions that this should be separately mounted enclosed type.

Item #11—Mounting — Unanimously agreed it should be left to discretion of Manufacturer whether to mount on common base or individual bases. Material to be Monson slate unless otherwise specified. Our Committee to arrange with Manufacturers' Committee for a schedule of thicknesses of slate for various H.P. and for a definite height of panel and definite distance from bottom of panel to floor. Width of panels to suit Manufacturers' requirements. Angle framework to be used and our Committee to arrange with Manufacturers' Committee for minimum size of angles to be used on panels for various H.P.

Item #12—Arrangement Connections—Wiring—Unanimously agreed that arrangement of devices be left to discretion of Manufacturer except that definite location should be arrived at with Manufacturers' Committee for line and motor leads, as well as, control terminal board. That a system of numbers designating each device according to the function it performs, similar to those used in switchboard diagrams shall be adopted by Control Manufacturers. Each device to be marked on front and back of board with this number. Terminals to be marked on back of board only. Device numbers to be duplicate of those now used on switchboards as far as practicable.

Item #13—Enclosing Covers—Unanimous opinion that our Committee should arrange with Manufacturers' Committee schedule of gage of material to be used, this to vary with size of panel. Hinged front single door up to 24" panel width double doors above that, no door to require more than 24" to swing full open. Hinged doors to be provided with device for applying padlock. Removable doors in rear. To be coated with primary coat of red lead and finishing coat of black paint or enamel, or with coating equivalent to above in rust resisting properties. Weatherproof and dust proof covers to be special and specified when required.

Item #14—Resistors—Unanimously agreed that our Committee should arrange with Manufacturers' Committee for uniform size of all resistor frames. Resistors to be separately mounted enclosing covers to be specified if required, purchaser to specify whether grid, ribbon or other type resistor required.

Item #15—Accessories—Unanimously agreed that push button master switches, limit switches, etc.,

shall be required to open but one side of control circuit, but that our Committee shall arrange with Manufacturers' Committee that separate fingers and separate lines shall be used for contactors that open opposite sides of power circuit. Master Switches and push buttons to be provided with devices for applying padlocks in off position.

Item #16—Wiring Diagrams—Dimension Sheets—Unanimously agreed that our Committee arrange with Manufacturers' Committee schedule of different sizes of diagrams to be used, practicability of putting resistance layouts on main diagrams and sequence table to be added, and agreement as to just what information shall be included on all wiring diagrams. Power lines to be at least two instead of four times width of control wires. Majority opinions favored use of conduit or cable method of showing control wires from panels to master switch, but some were favorable to showing each individual wire. Manufacturers' order numbers to be shown on diagrams, as well as purchaser's order, purchaser's specification number also be shown.

Item # 17—Repair Part Sheets—Unanimously accepted as written.

Item #18—Marking of Shipment—Customers specification numbers to be added. When shipping crate contains apparatus for different drives, each piece must be tagged for the drive with which it is to be used giving the same information as requested under item (A).

Item #19—Unanimously accepted as written.

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MEETING OF THE A. I. & S. E. E.—NEMA JOINT COMMITTEE ON STANDARDIZATION OF STEEL MILL CONTROL

PLACE OF MEETING: CRYSTAL ROOM, HOTEL WM. PENN, PITTSBURGH, PA.

DATE OF MEETING: MARCH 9, 1932.

MEMBERS PRESENT:

A. I. & S. E. E.

E. L. Upp	National Tube Co.
J. I. Kaspari	Weirton Steel Co.
H. F. Raab	Bethlehen Steel Co.
W. F. Riggs	Jones & Laughlin Steel Corp.
M. H. Morgan, Jr.	Carnegie Steel Co.
O. H. Meineke	Spang, Chalfant & Co., Inc.
W. E. Waldron	National Tube Co.

N. E. M. A.

T. D. Montgomery	Cutler Hammer, Inc.
W. J. Fleming	General Electric Co.
L. A. Watson	Clark Controller Co.
P. B. Harwood	Cutler Hammer, Inc.
L. E. Markle	Westinghouse Elec. & Mfg. Co.
D. C. Wright	Elec. Controller & Mfg. Co.

CHAIRMAN: T. D. Montgomery.

Mr. Upp, Chairman, and the members of the A. I. & S. E. E. Committee presented to the NEMA representatives the following questions and problems involved in the proposed Industrial Control Standardization for Steel Mill Auxiliaries:

1. Ratings of Industrial Control Contactors:
   a. It was proposed that a revision of the present NEMA Rule 120-513 be made to specify the contactor rating on the basis of tip nearly worn out. If possible, the wear allowance should be a definite percentage of the tip or wipe.
   It was moved and seconded.
   That NEMA would rewrite the rule to incorporate this suggestion.
   b. There is a requirement in Steel Mill applications for 2-OCO ratings of contactors. This rating to be expressed in per cent if possible of the 8 hr. rating and be the current which the contactor will rupture although it may be necessary to dress or replace the tips after the interruption.
   The NEMA Committee will study this question.
   c. The present operative overload specified by NEMA is now four times the motor rating. It is recommended that NEMA adopt a rule specifying a percentage above the 8-hr. rating of d-c contactors for operative peaks specifying the number of test operations at a time interval to differentiate this interrupting rating from that in "b". It is recommended that consideration be given to the Underwriters' Laboratories' Standard for Industrial Control, page 14, paragraph 108 which reads: "D-C. contactors rated in hp. other than for control of fractional hp. motors shall be capable of interrupting four times the current corresponding to the hp. rating, for fifty operations at intervals of 10 seconds."
2. The recently 8 hour and mill ratings of d-c. contactors as standardized by NEMA are:
   8 hour ..... 100—150—300—600
   Mill & crane rating ..... 133—200—400—800
   The A. I. & S. E. E. recommends the adoption of another rating above 600 amperes and recommended for consideration by NEMA a rating near 1200 amperes.
3. The A. I. & S. E. E. recommended the adoption of a standard number of accelerating points for mill controllers. NEMA has that which the A. I. & S. E. E. Committee will study and comment on.
   These standards are as per attached Appendix A.
4. The A. I. & S. E. E. Committee recommended that NEMA consider the requirement of one instantaneous trip and one delayed time element relay or equivalent on each panel. Further, that they establish an adjustment range for the relay giving a limit (four times suggested) at which each relay can always be set.
5. After considerable discussion regarding the use of shunt field relays it is recommended that the following plan be followed:
   a. Field accelerating relays. It was suggested that the A. I. & S. E. E. Committee and the NEMA Committee both make recommendations on the use of the field acceler-

ating relays, these recommendations to be combined at a later Meeting.

b. Full field relay to be used where necessary. It is considered necessary that the full field be had during basic acceleration.

c. Field protective relay.

1. Where a field protective relay is specified one shall be included in each side of line.

2. There is apparently a broad variation in not only the recommendation for the use of these relays but also in the requirements specified for their use. It is recommended that the Sub-committee individually study the use of field protective relays and at the next joint meeting consolidate the recommendations.

6. Line-switch on the panel. The A. I. & S. E. E. Committee recommends the use of a motor circuit switch enclosed on all open panels and on enclosed panels. This switch should be operated from the outside of the enclosure. This arrangement should provide quick make and quick break, provision for locking and protective feature to prevent opening the cover to the switch unless the switch is in the open position. This switch will be unfused.

Inasmuch as this will no doubt increase the size of the panels involved and the ultimate cost of equipment so constructed it is desired by the A. I. & S. E. E. Committee that they be given a general idea of what this will amount to.

The control switch for these equipments to be a double pole, double throw arrangement such that the switch when depressed will connect the control circuit to the line side of the main switch providing for test operation of the panel. The normal position of this switch will connect the control circuit to the motor side of the line switch for normal operation. The control circuit to be fused in manner such that the fuses will be effective regardless of whether the control circuit is connected to the line side or motor side of the switch.

The field discharge resistor will be a resistor or equivalent means such as material used in lightning arrestors connected permanently across the shunt field.

7. Bases.

The minimum thickness of base should be specified by the manufacturers and their Committee to make a further study of the use of individual bases versus common bases and the methods of mounting and supporting to minimize the breakage. The A. I. & S. E. E. Committee recommended that panel material be Monson slate unless otherwise specified.

8. Framework.

The A. I. & S. E. E. recommended the standardization by NEMA of angle iron frame supports for panels, suggesting that such angle iron frames be 2x2x5/16" for a panel support on switch sizes up to 300 amperes and 2½x3½x⅜" for a panel support for larger switches.

9. Panel Dimensions.

The A. I. & S. E. E. Committe recommends the adoption by NEMA of a 72" height of panel with a definite distance of 6" (approximately), from the bottom of the frame supports to the bottom of the base. The width is to be optional and depend upon the manufacturer.

It is further decided that a standard be made covering the distance from the front of the base to the side of the angle-iron parallel with the plane of the base.

10. Location of Terminals.

The A. I. & S. E. E. Committee suggested that there would be considerable advantage in a standard which gave specific locations of the various terminals and offered as suggestions towards this standard the following:

a. That the leads going from the panel to the resistor be at the top of the panel and the motor leads at the bottom. This would mean the accelerating contactors would be located at the top of the panel and the reversing contactors at the bottom. That the relative location of the contactors be given a definite sequence and relative location thereby providing for a definite arrangement of outgoing terminals and a general location of these terminals. Terminal boards for power leads are not desired. It is intended that the outgoing leads be taken directly from the contactor studs.

b. That the control terminal boards be not less than 12" to 18" from the bottom of the angle iron framework and be mounted either on the left or right hand side of the panel.

11. Wiring symbols and terminology.

The A. I. & S. E. E. Committee recommended the following for consideration:

a. The use of device numbers for each device function, these to be correlated with present Switchgear numbering system.

b. Make arrangements to have the control wiring to various studs shown in the relative location on the wiring diagram. It is desired that each wire be located on the panel exactly as shown on the wiring diagram. If this is not practical it is desired that the wires when shown on the wiring diagram as going to a certain stud will do so on the panel.

c. The device should be shown in the relative location on the wiring diagram.

d. Terminal markings on the back of the panel should be the same as on the diagram. Device markings should be included on the front of the board and agree with the wiring diagram. For this type of marking, stenciling is satisfactory.

e. Adopt a set of standard symbols additional to those now included in the N.E.M.A. Standards. It was suggested that this mat-

ter be referred to the NEMA Committee on nomenclature and symbols to set up the necessary standards.

12. Enclosures for panels.

a. Thickness of material. A question arose as to the thickness of material standard for these enclosures. Inasmuch as the Underwriters' Laboratories' standard covers a thickness of material it was decided that the A. I. & S. E. E. Committee would review this specification and if satisfactory it could be included in that standard. This standard is as follows:

Max. Vol. of Enclosure Cubic Feet	Max. Area of Any Surface, Sq. In.	Maximum Dimension, Inches	Thickness—U. S. Standard Gauge Without Supporting Frame	With Supporting Frame or Equivalent Reinforcing
¾	.....	12	20 (0.037 in.)	24 (0.025 in.)
1	.....	18	18 (0.050 in.)	20 (0.037 in.)
.....	360	24	16 (0.062 in.)	18 (0.050 in.)
.....	1200	48	14 (0.078 in.)	16 (0.062 in.)
.....	over 1200	.....	10 (0.141 in.)	16 (0.062 in.)

b. The A. I. & S. E. E. Committee recommended that the enclosure include swinging doors or hinge doors on the front of of the panel which do not require more than a 24" swing. The back of the panel is to be removable rather than hinged. When attaching the back of the panel it should not be necessary to hold in place the removable back while adjusting the fastening means.

c. Painting of enclosures for rust resisting.

The recommendation was made that all enclosures for mill work be given consideration in order to set up a standard finish which will be rust resisting to a greater degree than obtained with present finishes. It was suggested that this finish should be the equivalent to that obtained with a prime coating of red lead with a finishing coat of black paint.

The NEMA Sub-Committee will give this subject further consideration and determine a suitable standard.

13. Wiring diagrams.

The A. I. & S. E. E. Committee recommended the following standards covering wiring diagrams:

a. That the size of the diagrams would fit in the following groups:

Letter size, two-times letter size, four-times letter size, eight-times letter size, as a maximum.

Diagrams can be slightly less than these dimensions.

b. That a resistor table be included on the diagram.

c. That each diagram include a sequence table.

d. That a definite distinction be made in the size of line indicating control and power circuits.

e. That cabling of wires from the panel to master switches, limit switches, etc., be adopted to eliminate a number of wires paralleling each other.

f. That the wiring diagram accompanying an order be properly labeled as to purchaser's order, manufacturer's number, item number, etc. A sticker or stamping on the back of the blueprint is satisfactory.

g. The dimension prints should be separate from the wiring diagrams.

h. All diagrams should be a control schematic included on the main diagram.

14. It is desired that the dimensions of resistor frames be standardized. After considerable discussion it was decided that the NEMA Sub-Committee would make a study and determine if possible whether they could arrive at a standard for steel mill auxiliaries as to dimensions, ohms, and capacity.

15. Marking of shipments.

Crates should be marked with customer's item, order number, specification number and with the manufacturer's order number. Multiple shipments must have each item number specified on the crate in which they are included.

It was pointed out that this was apparently standard with each manufacturer and that while each would check up in their particular organization there is no reason why this should not be done if proper information is included with the order.

16. Contactor Coils.

The A. I. & S. E. E. Committee recommend that full voltage coils be used on all contactors and relays where possible and where necessary to use resistor tubes in series with the contactor coils. These tubes should be marked with the ohms and rating as well as the catalog number in order that they can be duplicated or replaced.

It is desired that all coils be given a 15% overvoltage rating rather than the standard 10% which now applies. NEMA Sub-Committee will make recommendations on this question.

17. Considerable discussion arose as to the proper safety features which should be incorporated on auxiliaries for steel mills. Mr. Upp presented a sketch with various methods of connection from safety standpoint of contactors freezing and grounds occurring. This question will be given further consideration by NEMA on arriving at a standard.

18. The A. I. & S. E. E. Committee proposed a method of indicating renewal parts for various equipments for the consideration of the manufacturers. This subject was left open to further study by the manufacturers for their recommendations.

W. J. Fleming,
Chairman, NEMA Sub-Committee.

APPENDIX A

D-C MILL AUXILIARY MAGNETIC CONTROL

Classification

The standard types of d-c mill auxiliary magnetic control shall be as follows:

(1) Non-reversing, utilizing resistor class 55.
(2) Non-reversing, dynamic braking, utilizing resistor class 55.
(3) Reversing, plugging, utilizing resistor class 53.
(4) Reversing, dynamic braking, utilizing resistor class 55.
(5) Reversing (plain), utilizing resistor class 55.

Contactor Ratings

Standard contactors employed for mill service shall be rated as follows:

Standard 8 Hour Rating Amperes	Mill Rating Amperes	Hp. Rating at 230 V.	Minimum Number of Contactors for Accelerating Only
100	133	35	2
150	200	55	2
300	400	110	2
600	800	225	3* or 2*

* As specified by the user.

Equipment of Controller

Each standard type of controller shall include:

(1) D.P. main line knife switch with lockout device.

(2) D.P. fuse control circuit switch.

(3) Two automatic reset overload relays.

(4) Under-voltage relay.

(5) Negative line contactor.

Supports for Controller

It shall be standard practice to furnish all d-c mill auxiliary control panels with supports for floor mounting.

A. I. & S. E. E.
SPECIAL MAGNETIC CONTROL COMMITTEE

E. L. UPP, Chairman and Superintendent of Electrical Dept., National Tube Co., McKeesport, Pa.

C. J. SMITH, Elec. Engr., Illinois Steel Co., Chicago, Ill.

E. C. MARSHALL, Elec. Supt., Youngstown Sheet & Tube Co., Gary, Ind.

R. E. LEWIS, Elec. Supt., Youngstown Sheet & Tube Co., Youngstown, Ohio.

J. I. KASPARI, Asst. Elec. Engr., Weirton Steel Co., Weirton, W. Va.

D. I. BOHN, Elec. Engr., Aluminum Company of America, Pittsburgh, Pa.

F. D. EGAN, Elec. Supt., Bethlehem Steel Co., Lackawanna, N. Y.

H. F. RAAB, Asst. Elec. Supt., Bethlehem Steel Co., Johnstown, Pa.

J. R. BAREFOOT, Asst. Elec. Supt., Carnegie Steel Co., Munhall, Pa.

R. F. SANNER, Asst. Elec. Engr., Carnegie Steel Co., Duquesne, Pa.

J. W. BATES, Elec. Engr., American Sheet & Tin Plate Co., Pittsburgh, Pa.

W. H. BURR, Elec. Supt., Lukens Steel Co., Coatesville, Pa.

J. O'MALIA, Ch. Elec., Otis Steel Company, Cleveland, Ohio.

W. W. GARRETT, Engr. of Tests, Elec. Lab., Tennessee Coal, Iron & R. R. Company, Fairfield, Ala.

O. H. MEINEKE, Ch. Elec., Spang Chalfant & Co., Ambridge, Pa.

W. F. RIGGS, Elec. Supt., Jones & Laughlin Steel Corp., S. S. Works, Pittsburgh, Pa.

M. H. MORGAN, JR., Engr. Dept., Carnegie Steel Co., Braddock, Pa.

C. H. VERWOHLT, Works Engr., Wheeling Steel Corp., Wheeling, W. Va.

G. GAGE, Plant Engr., American Rolling Mill Co., Butler, Pa.

J. B. SULLIVAN, Elec. Supt., A. M. Byers Co., Ambridge, Pa.

J. MALONEY, Ch. Elec., Superior Steel Corp., Carnegie, Pa.

J. D. KELVIE, Ch. Elec., Republic Steel Corp., Massillon, Ohio.

L. M. RIPPLE, Elec. Supt., Great Lakes Steel Corp., Ecorse, Mich.

W. A. PERRY, Supt. Elec & Pwr. Depts., Inland Steel Co., East Chicago, Ind.

F. H. KITTREDGE, Elec. Engr., Illinois Steel Co., Joliet, Ill.

J. S. DELANEY, Ch. Elec., Granite City Steel Co., Granite City, Ill.

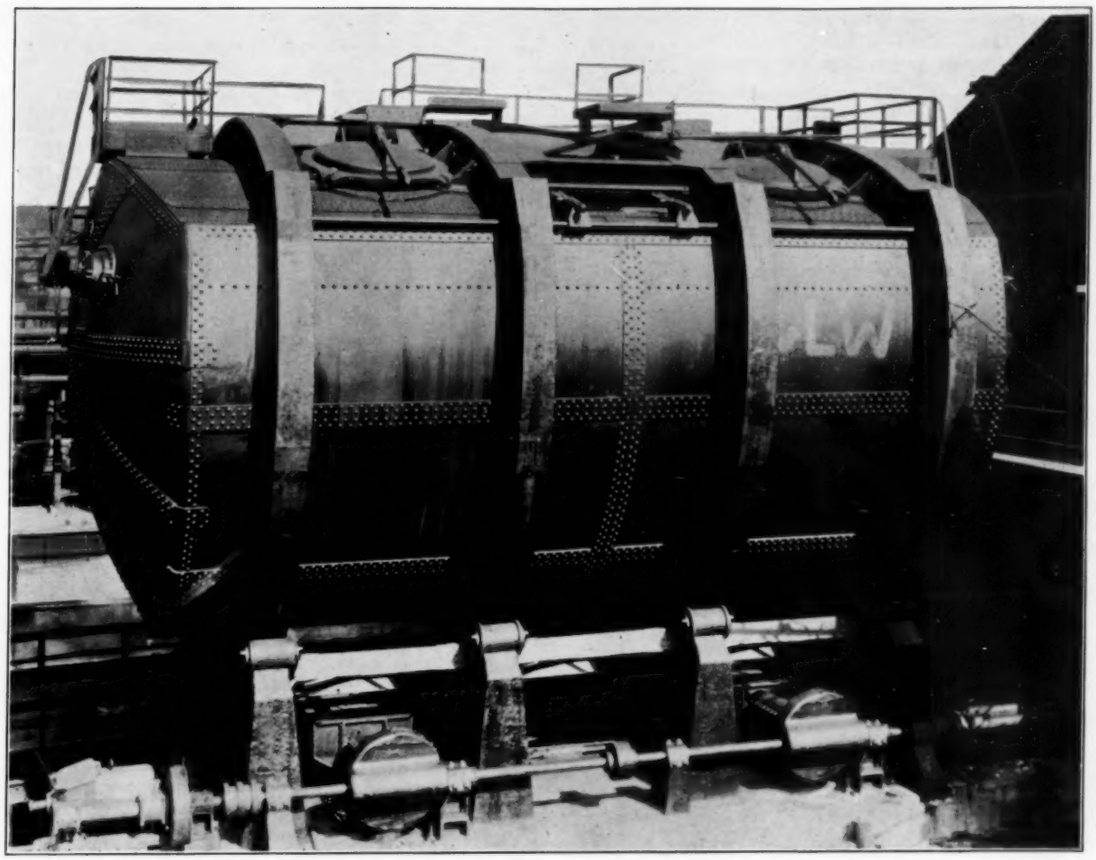
C. T. PHILLIPS, Elec. Supt., Sloss Sheffield Steel Corp., Kansas City, Mo.

I. N. TULL, Elec. Engr., Corrigan-McKinney Steel Co., Cleveland, Ohio.

R. S. HURTT, Elec. Dept., Pittsburgh Crucible Steel Co., Midland, Pa.

F. A. SNYDER, Elec. Engr., American Steel & Wire Co., Cleveland, Ohio.

E. L. ANDERSON, Elec. Dept., Bethlehem Steel Co., Sparrows Point, Md.



1700 Ton Hot Metal Mixer

Development of Hot Metal Mixers

Presented before Pittsburgh Section, Association of Iron and Steel Electrical Engineers, February, 1932.

By LEE E. ALLEN
Chief Engineer, Pennsylvania Engineering Corp., New Castle, Pa.

A hot metal mixer is a vessel or reservoir for the storage of molten iron. This container has hopper for receiving molten metal and is arranged to tilt and pour its contents through pouring spout in any quantities and at any intervals desired.

The purpose of a mixer, or reservoir, is for the storage of molten iron delivered from the blast furnaces or other sources and to store this molten iron and deliver same by pouring at any time and in such quantities as will best suit the requirements of the steel making units. It also serves the purpose of storage of iron from the blast furnaces over weekends or periods when the steel plant is not operating. One leading steel plant has a mixer storage capacity of four thousand gross tons.

The chief purpose of a mixer is to equalize the analysis of iron to the steel plant. That is, in the assembling of molten iron from the blast furnaces to the mixer, even though the chemical analysis of iron from the different blast furnaces vary widely, an almost uniform chemical analysis of iron to the steel plant is obtained. This is desired by a steel man so that his steel making operation is practically uniform one heat with the other.

Prior to 1889 when Captain Jones introduced the mixer into the steel works practice, liquid metal for Bessemer converters was either taken direct from the blast furnace or from cupolas where the pig iron was remelted. Irregularity in the quantity and rate of output often resulted from use of metal taken direct from blast furnaces, as variation in the composition of the iron was not uncommon and delays were sometimes occasioned in the supply of hot metal to the converter.

Mixers were used in Bessemer steel manufacture only until about the year 1900 when the use of molten metal for ordinary open hearth charges was developed.

With the open hearth furnace plant the mixer became a necessity for the open hearth furnace as well as for the various continuous processes conducted in fixed and tilting open hearth furnaces.

The mixers were first applied in the steel works as a collector of the various charges from the blast

furnaces, unifying the composition of the metal, and serving out the furnace charges as required. Since then it has developed into a storage unit, performing the function of collector, equalizer, and distributor. In fact, it is an important installation in a modern steel works.

Since then there has been a decided development in the shape of the mixer shells. Also the supporting means for the mixer has been decidedly improved and modified.

Much attention has been given in the design of mixers to the lining condition and supporting of same.

The early mixers were all built with open receiving hopper and pouring spout. In the modern mixers both of these openings are almost entirely closed, the receiving hopper having a hinged door which opens at the time of charging the mixer.

The mechanical part of the operating mechanism for the tilting of the mixer proper has been continually improved both as to design, strength, and efficiency.

Some of the smaller mixers were tilted manually; some few being tilted around trunnions by means of crane. Later hydraulic cylinders were applied for tilting and returning the mixer to its normal position. In recent years all the mixer installations have been electrically operated.

Certain safety means have been added from time to time on the operating mechanism and control to protect the mixer from accidents insofar as possible.

Up to the present time about one hundred thirty mixers have been designed and built in this country. All the mixers now in operation are either hydraulically or electrically operated. About sixty of the above mixers are electrically operated.

The mixers now in operation range in size from one hundred tons to seventeen hundred tons capacity. These mixers vary in type, design, and operation as further described. The limit to the capacity of mixers would seem is confined only to clearances of plants and their storage requirements.

The shape of the mixer proper has been a development based on its capacity, operation, and lining condition. The shape has also been developed for a better conservation of heat, ease of manufacture, and to suit the particular operating conditions of the plant where installed. Certain types of mixers suit certain plant conditions and clearances better than others.

Often it requires a special shape to meet the exact clearances and conditions where a mixer is installed in an operating plant to meet certain fixed conditions then existing.

The shape of the mixer, of course, is determined by the nature of molten iron to be handled and the capacity of mixer to be installed.

The shape of the mixer has been developed so as to avoid insofar as possible the cutting on the lining due to the charging of metal into the mixers or the pouring of metal from the mixers.

The first mixer, which was made by Captain Jones, was a rectangular box with no particular outstanding features of supporting or tilting mechanism.

From this rectangular box other shapes were developed such as ladle shaped mixers supported by trunnions and tipped by means of crane. The first common type of mixer, as we at present designate the unit, was the "Pumpkin Seed Type". This pumpkin seed type of mixer is still in evidence in a great many plants.

These mixers are supported on two cast steel rockers, the shell being eccentric with the rolling surfaces and rockers. These mixers were designed with comparatively shallow depth of metal for the tonnage stored. Also with extremely large void space between the surface of the metal and the roof.

On these mixers the receiving and pouring spouts, which were on opposite sides of the shell, were large and were not closed. The majority of the mixers of this type are from one hundred fifty tons to four hundred tons capacity, there being a very few above four hundred tons and none exceeding six hundred tons capacity.

These mixers required fuel at all times to maintain the temperature of the iron.

In the description above it has been noted that for the volume of metal stored the surface exposed was great in proportion, thus giving a large radiating surface from which initial heat was lost.

In order to obtain a larger capacity of mixer of pumpkin seed type it was necessary to increase the distance between the supporting rockers. This increase between the supporting rockers necessitated considerable reinforcement to the shell to carry the load of molten metal to the two rockers, thus increasing the expense of manufacture and the dead load of the mixer.

The roof of these mixers was arched but reasonably flat, the lining of roof being supported on the lining of the side walls.

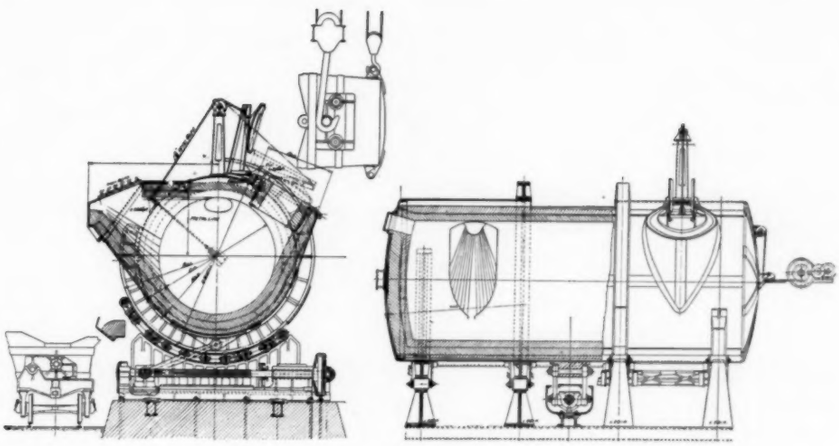
The next outstanding shape of the mixers was with the shell made spherical. A few of these mixers were designed and built and some are still in service. All of these mixers were from one hundred fifty tons to three hundred tons capacity.

These mixers had the same general features of two supporting rockers, pouring and receiving spouts, as on the pumpkin seed type with the exception of shape of shell. No reinforcement was required between the supporting rockers due to the shape of the shell. These mixers, however, had the objectionable feature of the pumpkin seed type in that the depth of metal was shallow in comparison to the radiating surface of iron, and the void space between the maximum level of the iron and the roof was large.

The spouts on the majority of these mixers were open, necessitating considerable fuel for heating.

A later development in the shape of the mixer body was the cylindrical shape mixer with spherical heads. These mixers were built with two supporting rockers for the smaller sizes, three supporting rockers for the intermediate sizes, and four supporting rockers for the larger sizes. These mixers were built from one hundred fifty tons to thirteen hundred tons capacity and have been designed for two thousand tons capacity.

These cylindrical mixers were designed with a depth of metal never before anticipated in a mixer of the given capacity, the mixers being designed so that the metal depth was about three-quarters the diameter of the inside of the lining thus decreasing the void space above metal and increasing greatly the depth of bath, and decreasing the radiating surface of the molten iron. This change in the design



Arrangement of
1300 Gross Ton Mixer

was a decided improvement in maintaining the initial heat of the iron due to the small radiating surface for the tonnage stored.

The first of these mixers was designed with one pouring spout and one receiving hopper. On a two-stand mixer the pouring spout and receiving hopper were on opposite sides of the shell. On the three-stand mixers the receiving hopper was located in one end bay of mixer and pouring spout on the opposite side of mixer in the end bay of the opposite end of mixer from receiving hopper. On the four-stand mixers the receiving hopper was in one end bay on one side of mixer and the pouring spout on the opposite side of mixer in the opposite end bay.

The mixers described are what is known as the standard design of the cylindrical type. Certain modifications to the arrangement and location of the receiving hopper and pouring spouts from the above were made to suit fixed plant conditions.

Another outstanding improvement of the cylindrical mixers was the closing of the pouring spout and receiving hopper.

All of these mixers were designed with removable lined cover over the pouring spout, entirely closing same with the exception of small opening for the stream of metal. Hinged electrically operated brick lined doors were installed over the receiving hopper. The doors on the receiving hoppers were operated by electric hoists located on the working platform adjacent the mixers through the necessary ropes and sheaves. Provision was made in the design of mechanism so that there was no change in length of cable between the door and hoisting unit at the time of tilting the mixer.

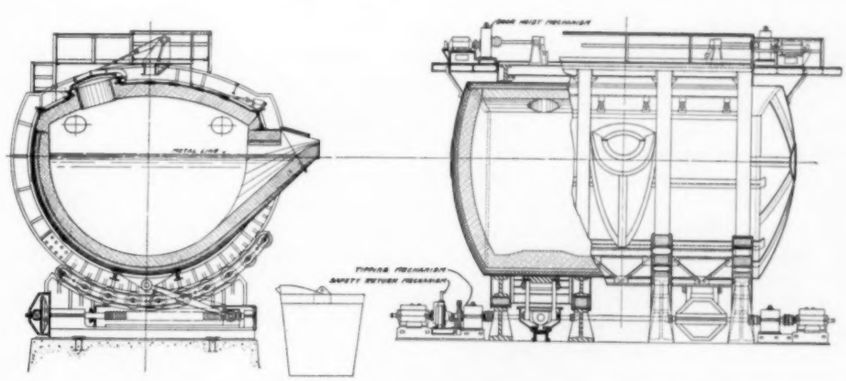
The hinged covers over the receiving hoppers closed on the brick lining around the hopper. As this brick lining was subject to cutting and wear, a removable cast iron or cast steel thimble was used at this point. This thimble was lined and could be removed and replaced by newly lined thimble after such time as the brick work deteriorated so that it was not fit for further use.

A later modification to the large mixers of this type was made by the addition of another charging hopper. In this design the pouring spout was moved to the center bay of the mixer, the receiving hoppers being installed complete with door and door operating mechanism on each end bay of mixer shell.

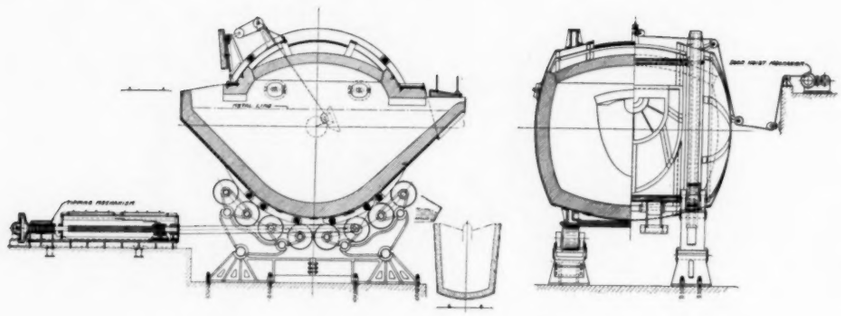
This was found to be quite an improvement particularly on the large capacity mixers. Better mixing qualities were obtained and, during the period the steel mill was down, fresh iron could be poured into either end of the mixer and thus maintain the heat in the iron more effectively.

The mixers of this type were almost all equipped with some type of burner, the fuel being dependent on fuel at the plant, but little fuel was needed in the operation of the mixers, same being burned only to

Arrangement
of
1700 Gross Ton Mixer



Arrangement
of
1000 Gross Ton Mixer



keep the slag fluid. At the time when the mixer was in active service, that is, receiving molten iron and discharging molten iron to the steel plant, no fuel was used.

A more recent development in the shape of the mixer proper was the barrel shape mixer. These mixers, as built, are supported on two rockers, the body of the mixer being a true barrel shape with spherical center conical ends and spherical heads. These mixers have been built up to one thousand tons capacity.

The advantage of the barrel shape mixer is that the center to center distance between the rockers may be almost any dimension required without any reinforcement to the shell, as described on the pumpkin seed type, the section of shell being such that stresses or loads on the shell due to molten iron are always in tension. This tension is counteracted by the necessary spreaders and tie bolts between the rockers.

These mixers were designed with the depth of bath and small radiating surface in mind as had proven so successful in the cylindrical mixers.

Another advantage of the barrel shape is that the lining is of the same contour and that the mixer will readily drain, and the lining is arched in all directions making a more permanent lining condition. It is interesting to note that since the barrel shape mixer came into popular use the advantages in the shape of it has been found and some of the cylindrical mixers have been since lined with the inside contour of the lining conforming to the barrel shape.

The same features as to enclosed pouring spout and receiving hopper are true on the mixers of this design as described on the cylindrical shape mixer.

Another advantage of the barrel shape mixer, particularly where a peculiar iron is to be handled, is that the receiving hopper is directly opposite the pouring spout, both the receiving hopper and pouring spout being wide at the connection of same to the shell, thus eliminating any dead corners or pockets where stagnant metal might collect.

The door operating mechanism on the barrel shape mixers were of the same design as those described on the cylindrical mixers. Lately, however, the door operating mechanism has been installed completely on the mixer with the necessary accessory platforms, all attached to the mixer and turning with it when pouring.

A later development of mixers, particularly for larger capacities, was the semi-cylindrical mixers with comparatively flat arched roof and with two, three, and four supporting rockers. The larger capacity mixers of this design had one pouring spout and two receiving hoppers, the pouring spout being in the center bay and the receiving hoppers in the roof in the outside bays on opposite side of the mixer from the pouring spout.

Any modification to the arrangement of the pouring spout and receiving hoppers on the semi-cylindrical mixers can be made to suit the exact plant condition. Removable brick lined thimbles in the charging hoppers are used on the semi-cylindrical type mixers for the same purpose as that described under cylindrical mixers.

These mixers, as well as the cylindrical and barrel shape, have the shell concentric with the rolling surface of the rockers. In the fabrication of same, the inside of the rockers are finished as well as the rolling surfaces.

On this design of mixer, as well as on the cylindrical and barrel shape, the shell of the mixer is designed with the necessary features for the support of roof of mixer lining independent of the lining of side walls. This means that in the event of cutting at the slag line or around the spouts, all necessary repairs can be made without disturbing the roof lining.

The necessary provisions are made in the design of this type of mixer to hold the arch of roof by means of ties.

The linings in the above described mixers range from fifteen inches to twenty-seven inches thick. The quality of lining varies from one plant to another due to plant practice or analysis of iron passing through.

The cylindrical, barrel shape, and semi-cylindrical mixers are usually lined twenty-four inches to twenty-seven inches thick.

It has been stated that the operating mechanism for the door of charging hopper is sometimes located on the working platform adjacent the mixer. In almost all of the later installations the door operating mechanism has been located on the mixer, providing the necessary access platforms, etc., to same for inspection and lubrication; the mechanism and platforms all turning with the mixer when pouring.

Where the door operating unit is located on the working platform adjacent the mixer, the hopper door is closed by gravity, the necessary brakes and limit switches being provided for its successful operation.

Where the door operating mechanism is mounted on the mixer, a more positive connection can be made between operating mechanism and the door. The door can be opened wider to clear the charging ladle and can be positively closed.

The operation of the door with either mechanism can be operated from the working platform, but in many cases is operated from the crane cab. The operation of the door from the crane cab by the craneman is no doubt the best and the safest, as the opening and closing of the door is in the hands of craneman, he being entirely responsible for both the operation of the charging ladle and the opening and the closing of the door on the hopper of the mixer.

The control equipment for the operation of these doors is dynamic braking control with the necessary slowing down features at closing.

Along with the development in shape of mixer body, there has been a decided improvement in the supporting means of mixers. All the mixers in service at the present time are supported on rockers attached to the shell of the mixer.

The earlier "pumpkin seed" type mixers were supported on rollers mounted on fixed shafts in cast iron stands. These rollers were lubricated through the fixed shafts. All the "pumpkin seed" type mixers are supported on two rockers, each rocker being supported on from six to eight rollers. There are a few "pumpkin seed" type mixers mounted on single equalized rollers. Some equalized rollers are of the fixed shaft type, and, in some cases, the shafts are pressed in the rollers, the shafts turning in the equalizers.

In all the above designs of supporting means, the bearing pressure on the shafts is extremely high and considerable trouble has been experienced in the lubrication of bearings. Also, in this type of mixer, the power requirement for tilting the mixer for the tonnage stored is excessive.

The majority of spherical shape mixers which were built have the stands of the mixer proper supported on horizontal tracks. In pouring, the mixer rolled forward on these horizontal tracks as well as turning. The problem of lubrication on this type of support was eliminated but the bearing pressure between the rockers and horizontal track was extremely high, thus explaining the moderate capacity of mixers of this design.

Cylindrical mixers have all been supported on roller bearings, that is, the rockers on shell were supported by a train of rollers mounted on stands machined to the same contour as the rockers, the rollers being free to move on the stands as a true roller bearing. Each set of rollers was combined into one roller race. The load of the mixer was then transferred directly through the rollers to the supporting stands.

In this design, the line bearing per inch length of roller was decreased and the power requirement for the operation of the mixer was decidedly decreased.

The barrel shape mixers, in the majority of cases, have been supported on true roller bearings the same as cylindrical shape mixers. In one case, however, a barrel shape mixer was supported by means of double equalized rollers.

In this instance the rollers were of large diameter operating on fixed shafts in the equalizers. The rollers had cored pockets in the center of same for carrying oil for the lubrication of the bushings on shafts.

The semi-cylindrical type mixers, in most cases, have been supported on roller bearings the same in design as that described for the cylindrical and barrel shape mixers. Some few, however, have been supported on equalized rollers.

The power requirement, we believe, is always less on mixers supported on roller bearings. Also, the mixers supported by roller bearings have the decided advantage that there is no lubrication problem to solve.

We have discussed the development of the shape and the supporting means of mixers. A corresponding improvement has been made in the operating mechanism.

The first mixers built, as we at the present time understand mixers, were hydraulically operated. The "pumpkin seed" type mixers were designed to be operated by opposed hydraulic cylinders.

As these mixers were of shallow depth of metal, the angular turn of mixer to drain was small. The straight-line motion of the plunger interconnecting the two cylinders was transferred to the shell by means of sliding bronze nuts in machined ways in steel castings attached to the shell.

When the mixers were designed for the greater depth of bath, the angular turn was greater. In some cases this angular turn has been sixty degrees, which made it impossible to transfer the straight-line motion of hydraulic plunger to the angular turn of the mixer shell by the same simple means. In some few cases, connecting rods were used between the plunger and shell.

On the spherical shape mixers, these were operated hydraulically by means of pivoted cylinders standing in an almost vertical position, one cylinder being on the pouring side and one on the receiving side of the mixer. The force of the plunger of cylinder was transferred to the shell of the mixer through a pivoted connection which rotated and advanced the mixer proper on the horizontal track.

The pumpkin seed type mixers were all made hydraulically operated up until 1907 when one pumpkin seed mixer was installed operating electrically.

When the cylindrical type mixers were first put in service, and in the new design of same, electric current was used for their operation. Motors were installed together with the necessary gear reductions to a screw, or screws, depending on the size of the mixer. One screw was used on the smaller sizes of mixers and two screws on the larger sizes, the driving mechanism of the two screws being interconnected.

When this design of screw drive was made, the necessary provision for the guides of cross-heads and trunnions for the connecting rods were provided. A bronze nut was used in the cross-head for the operation on the screw.

Some of the mixers of this design are operating with open screw not protected from the graphite and ordinary flying material, which is always present around a mixer installation. In the majority of screw driven mixers, the screw is entirely enclosed, excepting the opening for the connecting rod travel, the screw and nut being operated in an oil bath.

This type of drive has been used on cylindrical, barrel shape and semi-cylindrical mixers.

After the screw drive on the cylindrical mixer had been thoroughly tried out in service quite a number of the old pumpkin seed type mixers were changed from hydraulic operation to electric operation.

The operating mechanism in the majority of cases is installed directly underneath the mixer. This is due almost entirely to the fixed operating conditions. In some few cases it has been possible to install the driving mechanism out from under the mixer, using long connecting rods. This feature is very desirable where possible as a protection to the tilting mechanism.

The first design of a drive of the screw type was made using the standard motor gears for the first reduction, cast steel bevel gears for the second reduction and babbitted thrust bearing on the screws, with flanged and square jaw clutch couplings on the shafts. The interconnecting shafts being supported on independent babbitted or bronze lined bearings.

After the first few electric operated mixers were installed, the cast steel gears with cast teeth were changed on the future mixers to forge steel pinions, cast steel gears with cut teeth. This practice has continued, improving the quality of the material in the pinion and gears.

The larger sizes of mixers have all been provided with two motors, either of which is of sufficient horsepower to operate the mixer. The feature of two motors is desirable on mixers of any capacity.

Some of the smaller mixers have been installed with single motors for economical reasons.

Where two motors are installed, the motors are interconnected by means of shafts and couplings, some necessary provision should always be made so that either motor may be disconnected from the driving mechanism. On some of the early electric pumpkin seed mixers, the motors could not be disconnected. The gears throughout have always been provided with gear shields of some design. In many cases these shields only served the purpose of guards and did not exclude flying particles.

These drives have now been improved so that instead of using standard motor gear as the reduction at the motors, a completely enclosed, anti-friction, helical or herringbone gear reduction is furnished adjacent the motors. The necessary high grade flexible couplings of the disconnecting type is installed between motor and gear reduction with equally good flexible couplings on the interconnecting shafts.

The cut bevel gear is mounted on the end of screw and is entirely enclosed with its mating pinion in a housing machined and fitted integral with the thrust bearing and cap, the pinion shaft being mounted on anti-friction bearings installed in the gear housing. This is a great improvement over the previous design and decreases the power requirement. The life of the equipment is lengthened due to improved lubrication and also the total exclusion of foreign material.

The screw is still operated with babbitted thrust bearing. This bearing has given good results and we know of no failure or trouble at this point. The thrust bearing is now lubricated from oil reservoir under the thrust bearing.

Another development in mixer drives is the geared type drive. On mixers of this design, racks are attached to the shell or rockers of mixer. This rack or racks engage pinions mounted on the operating shaft. Mixers of this design are provided with one, two or three racks, depending on the capacity of the mixer.

In order to obtain the necessary gear reduction between the motor and rack pinion, worm gear reductions and helical gear reductions are used. There has been the same improvement on the screw type drives on this type of drive as has been made.

On the later type of mixers, where this type of drive has been used, all bearings in the worm housing and gear housings are anti-friction type of bearings, the housing of same being completely enclosed.

In the improved drives, both of the screw type and gear type, the lubrication of bearings and gears is simplified and the life of the mechanism is increased and the power requirement is much less than with the older types of drives. The increased efficiency of the drives as explained has increased the drift of the mixer due to the inertia of motor armature and other rotating parts.

The first mixer electrically operated was built in 1907 of the "Pumpkin Seed" type provided with simple electric control, no special provision being made as to safety outside the usual precautions of limit switches, at that time known by the steel trade as the only precaution.

Between the years 1907 and 1913 we have no record of any electric operated mixers being furnished. It was in the year 1913 that the cylindrical mixer was designed and put in operation.

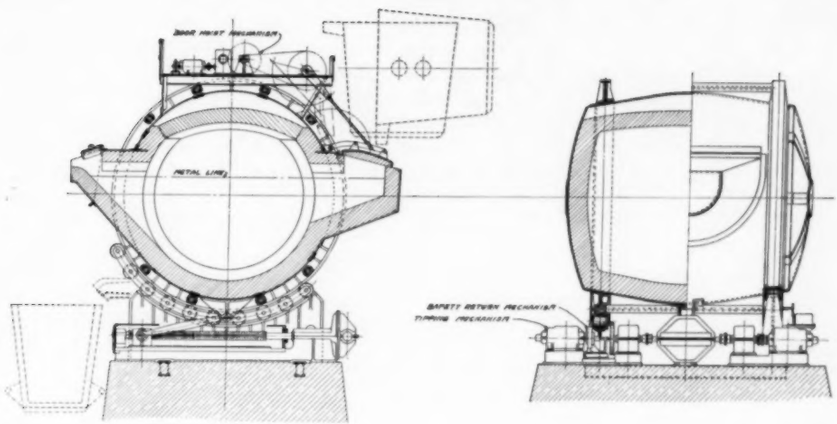
The first cylindrical mixer was put in service in 1913. This mixer was furnished with two motors and series brakes, single duplex control with single standard master, operating motors in series in pouring direction and in parallel in the return direction. Knife switches for cutting out either motor and transferring brakes were furnished. The limit switches on the control circuit were hatchway limit switches, one on either limit of travel.

The simple control just outlined was installed on the first few cylindrical mixers. To avoid any possibility of accident in the operation of mixers, this control has been constantly improved and modified up to the present time. We wish to give the steps in this development of improved control which has been made to eliminate the possibility of accidents with reference to the operation of hot metal mixers.

The next step in the control for hot metal mixers was on a mixer using two motors with no brakes. The control for this mixer consisted of two separate controllers with a single standard master and an auxiliary master to give series and parallel operation, the hatchway limit switches being used at each end of travel.

The next development in the control on a mixer with two motors, no electric brakes, separate control for each motor, operated in parallel from a double master with spring return to the "off" position. The control circuit limit switches were also furnished with spring return. The masters were detachable so motors could be operated independent or in unison.

Another step in the improvement of the control was the furnishing of two separate controllers, op-



Arrangement
of
600 Gross Ton Mixer
Barrel Type
Screw Drive

erated from a single master, with auxiliary master, to give series or parallel operation. On this control the control-circuit limit switches were of the gravity return type.

In about 1918 the above control was modified by the introduction of what is known as the "dead man" master.

In about 1923 an additional feature was introduced into the control equipment of the hot metal mixers. Prior to this, limit switches were provided in either direction on the main control circuit. At about this time an additional limit switch was provided on each end of travel in addition to the regular limit switch. This limit switch disconnected the current on the main line to the control circuits. Also about this time the control circuit limit switches were equipped with two contacts in parallel for each circuit, in order to guard against the hazard of losing one contact.

To summarize the above, after the first very few electric installations, spring return controllers to the "off" position were installed. That is, in the event the operator left his position while the mixer was pouring forward, returned the controller to the "off" position, thus preventing the mixer advancing any further.

Provision was made in the first mixer installation for electric brakes. Later when two motors were used on mixers, two separate control circuits, one for each motor, were applied. The controllers for these two circuits were interlocked so that operation was as one unit. This complicated the release of brakes when one circuit was disconnected.

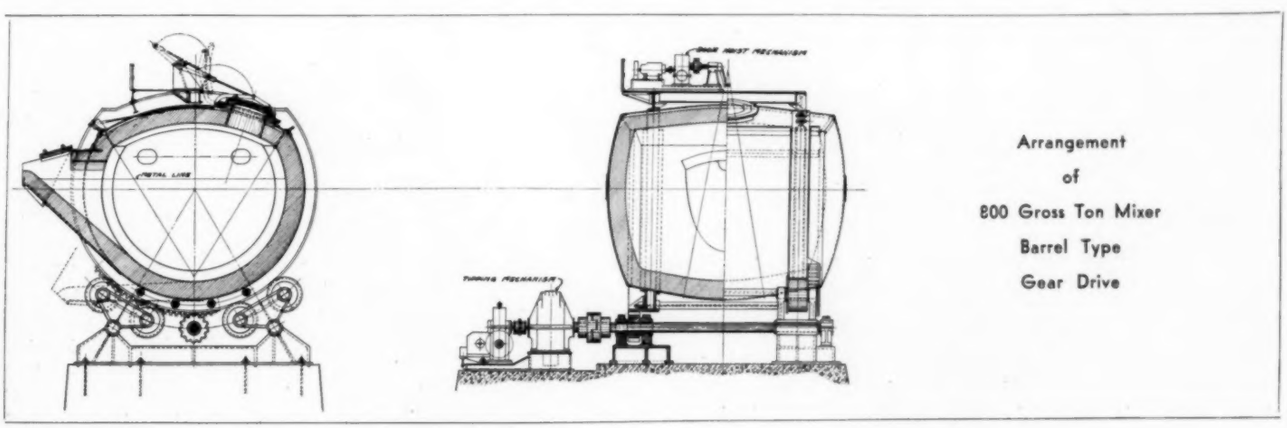
Through experience it was found that electric brakes were not necessary for the successful operation of mixers due to the fact that screw mechanism or worm gear mechanism used in the drive were self-locking.

On all mixer control circuit limit switches were provided for the limits of travel. These limit switches were first installed as spring returned the same as the controller.

Later the electric equipment was modified in that the limit switches and controller were gravity returned. This was some improvement over the spring returned in that the springs at times became defective or broken and would not function.

A little later instead of the controller returning to the "off" position in the event the operator left his position, a unit known as the "dead man" master was inserted. This dead man master was in addition to the regular operating masters and had to be held in position while the controllers were operated by the other hand. These "dead man" masters were first made with spring returned, but recently were of the gravity returned type.

In the event the operator becomes frightened and leaves his position, regardless of the position of the controllers, the dead man master, due to its spring or gravity return, will reverse the operation of the



Arrangement
of
800 Gross Ton Mixer
Barrel Type
Gear Drive

mixer and return same to its normal position, the operation being continued until the limit switches are contacted.

It was found, from experience, that control circuit limit switches at times were not in proper adjustment and a second limit switch was provided beyond the regular limit switch to cut off the line current to the controllers and motors in the event the control circuit limit switch did not function.

The switch used for this purpose has been the "Youngstown" limit switch.

The necessary provisions for the tripping of limit switches were provided with the mixers.

In the first few installations of "Youngstown" limit switches, in the event of its being tripped, had to be reset by hand before the mixer could be operated. This switch has now been modified so that this is not necessary.

In addition to the above electrical features which have been added from time to time, some plants, as an added precaution, have installed a complete double set of control equipment. This is to offset the possibility of one set of control equipment being damaged or burning out due to mixer spill or otherwise. Also some plants have connected their control equipment to two or more power circuits. This is necessitated from the fact that at certain times in plants the electric power fails at the instant when the mixer is in the pouring position.

If this occurs, where the plant is fortunate enough to have more than one power supply, by means of switches easily accesible to the operator, the power can be obtained from another source to return the mixer without any serious difficulty.

The possibility of more than one power line occurs only at a few plants. At other plants, to offset this power failure at the critical moment, the plant has installed storage batteries which can be connected into the regular control circuit and return the mixer from this position.

All of the above protection is based on the motors and control equipment being in good order and condition. It is not always possible to guarantee this to be true.

Within the last few years or since 1928 there has been added the air engine return feature, twenty-five of which are now in service on electric operated mixers. A compact rotary air engine is installed in connection with the driving mechanism so that, in the event of electric power failure, air may be turned into the engine through a valve located at the operator's position, which will furnish power to return the mixer so that no serious spill or loss of metal from the mixer can be had.

These air engines are installed in connection with the driving mechanism so that they are not in operation when the electric current is in service.

The application of this engine is made in two different ways, one by means of tilting base plate operated by an air cylinder, and the other by an air operated clutch. In both cases, the air is admitted to the engaging cylinder before air is admitted to the engine, the engaging of same being made through gears or clutches. The air is then admitted to the engine for its operation.

The engines installed are of the non-reversing type and operate the mixer only in the return direction. The air valve in the operator's pulpit is in most cases a manually operated valve. In some few cases two or more operating valves have been installed at different positions adjacent the mixer so that the mixer may be returned by air from various points.

In order to guarantee an air supply of the required pressure, a receiver is furnished together with small compressor of the rated pressure. The receiver, however, is usually connected to the plant air line by a check valve. The small compressor, usually located adjacent the receiver, is full automatic electric controlled from the pressure in the receiver, thus guaranteeing the required pressure in the receiver at all times.

This air receiver is of such capacity that it will furnish air to the engine long enough to return the pouring spout approximately twenty-four inches which will shut off any flow of metal from the mixer.

The air return is usually tested at certain intervals to guarantee that it is always in operation.

Another feature installed in connection with the air piping, between the operating valve and engine, is a safety gravity shut-off valve operated by a cam attached to the mixer proper. This safety shut-off valve is in the nature of a limit switch which shuts off the air to the engine when the mixer returns to its normal position.

Another feature recently added to the electric control, is that in the event the receiver is not up to the required pressure for the operation of the engine, the mixer cannot be driven forward to pour electrically.

In one or two cases in addition to the manually operated air valve on the operator's platform, there have been installed in parallel with this valve, a solenoid operated valve which is arranged and connected with the mixer control circuits in such a way that if the electric current fails at any time, regardless of the position of the mixer, the air is turned on the engine.

In addition to the safety precautions just mentioned, some few electric operated mixer installations have been provided with a counterweight return. A heavy counterweight being suspended and connecting through ropes and drums to the operating mechanism will return the mixer in event of current failure.

Electric brakes were used on first few electric operated mixers, but later it was found that these brakes were not required. The driving mechanism was always designed and furnished self-locking either from the screw or worm, so that the mixer even though unbalanced could not drift in either direction without power. The elimination of the brakes eliminated some complicated features with reference to the control. As each motor was connected to its own control circuit it was necessary that in event that one circuit had to be cut out for any cause the brake on motor of that circuit had to be released even though its motor control circuit was not in service.

Due to improvement in design of the driving mechanism as to gears and bearings and in the lubrication of same, it is now becoming apparent that electric brakes will have to be furnished with the motors to avoid the drifting of the mixer after the power has been turned off. With the use of the emergency air return, these brakes if installed

will have to be released by air as well as by electric current. It is entirely possible to furnish the brake released both by air or electric current, and use of same may be necessary on the improved drive.

In connection with the battery return, which was previously mentioned, there is a development under way at the present time, in which an auxiliary motor is installed in connection with the driving mechanism similar to the air engine.

This auxiliary motor will not function or be engaged to the driving mechanism while the regular electric current is in service. In the event of power failure from the main circuit, through certain control equipment power may be supplied to this auxiliary motor from the batteries so as to return the mixer out of danger or to its normal position. The connection between the auxiliary motor and the driving mechanism is by magnetic clutch.

In all the above features as to safety and return, it has been assumed that the driving mechanism has not failed. In fact, we know of few cases where any serious difficulty has been encountered through failure of driving or tilting mechanism.

Accidents can be caused by the lack of power, mis-adjustment of limit switches or control equipment on electrically controlled mixers, and broken piping or operating valves on the hydraulically operated mixers.

In this connection, the hydraulically operated mixers, as above described, are operated by opposed cylinders. Due to the difficulties in operation and otherwise, some of these mixers have been modified in that they are counterweighted for the return of same. In other words, water pressure is only used in the pouring direction, the mixer at all times being returned by the counterweights.

In this event, it means that broken piping or defective valves will not prevent the mixer from returning and thus shutting off any flow of metal at the time the pipe is damaged, the mixer always returning by gravity to its normal position.

There are a few mixers on which a certain precaution has been taken in the event the mechanical operating mechanism fails. This is by installing on the mixer and attaching to it a heavy rack. This rack is engaged by a pawl fixed to the foundation or other fixed point of the mixer, the pawl being disengaged by the operator from the operator's platform before turning the mixer forward to pour. This feature is only effective providing the connecting rods or connection between the driving mechanism and the mixer proper fails, and also in the event the mixer becomes unbalanced sufficiently to cause it to drift forward.

We do not believe there are very many mixers which would drift forward under its own unbalanced load, if the connecting rods or connecting gears were broken.

This pawl, as above described, is usually operated from a floating platform on which the operator stands while operating the controller. In order to offset the possibility of turning the power on in the forward direction while the pawl is engaged, this floating platform is connected electrically with the forward control circuit so that in the event the floating platform is not depressed, thus disengaging the pawl from the rack, it is impossible to drive the mixer forward.

Accidents may be caused by the wearing away through natural causes of some vital part of the operating mechanism. It is imperative, in the operation of mixers, with the hazard involved, that period and systematic inspections be made of the vital points of the mechanical and electrical features. There should be no excuse for an accident happening from the ordinary wearing of parts.

To summarize the mechanical safety features now incorporated in the design of hot metal mixers, we would give the following:

Large factor of safety in design.

High grade material and workmanship used in fabrication.

Completely enclosed mechanical parts.

Good lubrication to all wearing parts.

Abundance of horsepower in motors.

Easy inspection to all parts.

The outstanding electrical safety features are:

Use of two motors.

Independent control for each motor.

Dead man master return.

Double limit switches in both directions.

All switches and dead man master of the gravity type.

Two or more sources of electric current if possible.

Complete double set of control.

Use of storage battery for current in event of current failure.

The auxiliary features which have been used and contemplated on mixers up to the present time, which features have been added to the standard mechanical and electrical safety features, are as follows:

Counterweight return mechanism.

Air engine return complete with receiver and compressor.

Independent motor with complete storage battery and its auxiliary control features.

Positive locking device on shell to prevent drifting if the operating mechanism fails.

Guaranteed air pressure in receiver for air engine operation or guaranteed voltage in storage battery before mixer can be driven forward to pour by the regular electric control.

In the foregoing we have attempted, without going into the full details, to show the development in shape, supporting means, tilting mechanism, electric control, auxiliary safety features of hot metal mixers in the past forty-two years of their use. We know that we have not as yet reached perfection in any of the developments, but we as engineers will strive, with the help of the operating departments of the steel mill, to improve the design, operation and safety of the hot metal mixers in the future.

The Storage Battery Protects Hot Metal Equipment

By K. W. GREEN
Engineer, Electric Storage Battery Company, Pittsburgh, Pa.

Presented before Pittsburgh Section, Association of Iron and Steel Electrical Engineers, February, 1932.

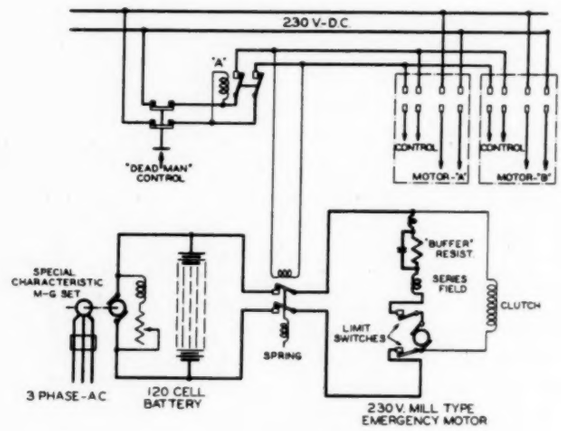
Consider the emergency storage battery. It prevents a panic by protecting the lighting circuits of your theatre or public building. It may be the means of saving your life by lighting the operating room of a hospital during a power failure. Every time you lift the receiver of your telephone, the storage battery is standing guard, back in a central office, helping to insure continuity of your telephone conversation. The storage battery is the last piece of electrical equipment you have pinned your faith on tripping a circuit breaker when all other power has failed. It is now ready to protect hot metal electric drives.

Years ago the majority of our rolling mills were driven by steam engines; they were modernized by replacing with electric drives. Hot metal mixers were tilted by hydraulic power. The modern barrel-shaped mixer is rolled by electric drive of either one or two motors together with individual control. You have progressed, but spills, that fortunately are infrequent, compel you to recognize the need for emergency protection. Why consider mechanical protection schemes when a simple electrical method is available?

What is this electrical method? It is the application of the storage battery to protect the power circuits feeding the hot metal equipment combined with a motor drive, that is either separate or a part of the regular drive, used to right the equipment during an emergency. The storage battery is the logical power to use because it is dependable, as evidenced by its use for control bus service by equipment manufacturers.

We proposed, in a local steel plant, to protect the power source only but it was rejected because it was felt that an emergency motor in addition to the storage battery would better secure their desired protection. There were as many control schemes as engineers interviewed and it was decided to choose one simple scheme, bring it to the attention of your Association, and try to evolve some standard method.

Our discussion may seem to center around the hot metal mixer where protection is first needed, but there is no reason why we cannot make this same application to the Bessemer Converter or to the tilting open hearth.



The mixer in most cases is driven by one or two 90 H.P. mill type motors having a separate master controller for each motor. In previous mechanically protected schemes, the emergency protection was applied to the back end of one of the main drive motors. A disabled armature was apt to block the emergency drive, so that it was finally applied to the center of the main drive shaft, or between the two bevel gears which drive the two worm gear shafts. At this place we would apply our emergency mill type motor which would engage the main drive shaft through an electromagnetic clutch. The emergency motor would be a 230 volt mill type motor providing interchangeability with other mill equipment. It would drive in one direction only and receive its power from a 120 cell storage battery that is continually floated on an M.G. set that receives its power, in turn, from an A.C. source. This scheme provides dependable protection that is flexible.

Refer to the diagram of connections. The control to the main motor drives is brought out separately and fed from a two pole contactor in order to prevent a possible "bucking" action between the emergency motor and mill drive motors. Between this contactor and the 230 volt bus is interposed some form of "dead man" control. This type will vary with individual plants, some preferring a foot type, others an overhead controller arm type, or perhaps a push-button type. A voltage or power failure, or opening of the "dead man" control will cause the primary contactor "A" to drop out thereby clearing the control on the main panel boards.

The emergency motor has a small "buffer" resistance in series which may or may not be shorted out after it starts. Switch "B" is a heavy duty spring closed, solenoid-opened contactor which closes upon failure of control voltage from contactor "A". If the mixer is tilted the limit switches will be closed and when contactor "B" closes, the clutch engages the motor with the main drive shaft and the mixer is returned by the storage battery. A return of normal power service automatically restores the electrical connections to their original setting.

In most cases, A.C. is nearby so that flexibility is introduced by having the motor of the M.G. set fed from three phase A.C. source. It is possible that the D.C. may have failed without failure of the A.C. so that the set continues to carry a portion of the emergency load. The battery is floated on the M.G. set at all times in order to insure having full capacity available when needed. Its size is determined by load conditions and also that time protection desired by the engineer.

The storage battery has the added advantage of providing emergency lighting about the hot metal equipment. Of course, A.C. has been substituted for D.C. lighting in late installations, but the addition of a positive and negative plate to each storage battery cell plus a simple throw-over switch will provide approximately 20 amperes of emergency lighting for an hour.

Storage Battery power is reserve power in one of the most concentrated forms. Of the three most widely employed methods of storing energy for future use, that is compressed air, the storage battery or a steel spring, the storage battery is not only the lightest in weight; but, also, the most compact. Compressed air, for instance, at 1000# pressure, develops power enough to lift its own weight including the steel tanks not more than 7000 feet; and a steel spring can lift its own weight not over 500 feet; but enough power can be stored in an electric storage battery to lift its own weight more than 32,000 feet or 6 miles. In other words, to store the same amount of energy a spring would weigh over 250 times more than a storage battery; and compressed air and tanks would weigh more than 5 times as much as the battery.

No doubt you have visualized a very large and costly installation to protect a 1300 or 1500 ton mixer. Let us briefly analyze the power requirements in the average case. The maximum observed power required to tilt the mixer is approximately 75 H.P. To return the mixer, power requirements vary anywhere from 15 H.P. to 65 H.P., dependent on the design of the mixer. On either main drive there is a 4 to 1 gear reduction between the motor and drive shaft. In order to provide duplication, use the same 4 to 1 gear reduction in the center of the drive shaft. The clutch is placed between this gear reduction and a second 2 to 1 reduction followed by the emergency motor. These gear ratios have been chosen at random in order to illustrate the application.

At 65 H.P. return load, the motor speed will approximate 450 R.P.M. The torque T in pound-inches at the main motor pinion is

$$\frac{63025 \times \text{H.P.}}{N} = 9100 \text{ \#-In.}$$

Since the same gear reduction was chosen between the clutch and main drive shaft, the size of the clutch is determined by this torque and will be either a 20" or 24" size.

If the 2 to 1 gear reduction is used between clutch and emergency motor, the H.P. required at the emergency motor pinion will be approximately one-half that required at the main motor pinion or 35 H.P.

Choice of protection period will vary with individual plants. Present mechanical protections furnish about 2 minutes reserve which, of course, may prevent continuous operating schedules. In the proposed electrical scheme, certainly a 20 minute reserve should provide a liberal factor of safety. For such a reserve a 120 cell storage battery of about 160 ampere hours capacity (at the 8 hour rate) will be required.

The M.G. set will probably be about 2.5 K.W. or 3 K.W. at 280 volts. The only load carried by the generator most of the time will be the trickle charge required by the storage battery, so that the generator characteristic should be so chosen that the floating voltage is stable at very light loads.

The room space required by the storage battery above, if assembled on standard two tier racks, will be about 8½ ft. by 10½ ft. You are familiar with the space requirements of the M.G. set and the mill type motor.

The storage battery application provides:

1. Dependable reserve power.
2. Simplified and automatic control. Only two contactors in the proposed scheme must operate in an emergency.
3. Additional protection for emergency lighting if desired.
4. Proportionately lower installation costs if more than one equipment is protected from the same storage battery.
5. Continuous operating schedules.
6. A safe mixer return not subject to dangerous inertia forces.

Electrical and Mechanical Equipment Proposed for the Prevention of Hot Metal Spills Used in Connection with Hot Metal Mixers, Bessemer Converters, Tilting Open Hearth Furnaces and Ladle Cranes.

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DISCUSSION

▲ By L. A. WATSON
Chief Engineer, The Clark Controller Co., Cleveland, O.

Presented before Pittsburgh Section, Association of Iron and Steel Electrical Engineers, February, 1932.

You have heard from the speakers tonight a very complete outline and description of hot metal handling machinery from its early use to present day modern equipment. So I will not take up any time reviewing what has been covered by the former papers, except to explain some features of the combination electric-air operated brakes now being used on the tilting motion of the hot metal mixer.

As has been stated this evening, brakes were unnecessary on former equipments, but we are now using larger motors and in the improvement in gears and bearings it has been found that the mixer will drift too far when stopping, so series brakes have been added. Now with the installations of the safety air engine it was necessary to lift the electric brake so air engine could return mixer to the normal position.

We have developed a special brake for this application. It consists of a standard series brake with the addition of the air cylinder which will release the brake when air is released to the air cylinder. When power fails during pouring operation, air is released to air engine and air cylinder of brake releasing brake, permitting air engine to return mixer to normal position. When air is cut off from air engine brake will set.

We believe this brake meets all the safety requirements and there has been no mechanical trouble with this type of brake.

▲ By WALTER de FRIES
Chief Engineer, William B. Pollock Co., Youngstown, Ohio

Inasmuch as the previous speakers have dealt so thoroughly with the protection of stationary hot metal handling equipment, I will limit my remarks to movable hot metal conveying means, such as mixer-type hot-metal cars and liquid slag carriers. The size of such equipment is naturally much smaller, than the regular mixers heretofore discussed, varying from 80 to 160 ton capacity for modern hot metal cars and from 400 to 1200 cu. ft. of slag capacity for cinder cars. These cars carry their own operating mechanism for the tipping of their containers, usually powered by electric motors, whose motion is transmitted to the ladles by worm-gear or screw-type drives, patterned after those in use on stationary mixers.

Naturally it is not feasible for economic reasons to protect such equipment with the elaborate auxiliary devices just described and to illustrate, what can be done in such cases by more simple means let me recite an incident, which occurred about a year ago in Birmingham, when iron was poured from a mixer type car into a new pig machine installation.

The electric power failed, when the ladle was about half emptied, leaving the operator without means to stop the flow into the pig machine trough. The metal kept on overflowing from the moulds on the strand to the next ones behind, before the attendant at the pig machine trough mastered the situation by grabbing a long handled shovel, with which he picked up some earth from the yard surrounding the concrete foundation. This he plastered with expert swings right into the spout of the ladle, stopping the flow of metal with the second shovelload.

Of course the spout of a ladle is small and the flow slow, when iron is poured over the pig machine and such simple and effective means for prevention of spills may not be applicable with equal ease and convenience to the larger mixer spouts with their faster flow rate. On the other hand we should remember, that the quite rapid flow of iron from the blast furnace over the cast-house floor is controlled by means of gates and sand, which suggests, that the idea of stopping the flow of iron at the spout be given some consideration.

The plant referred to now makes it a practice, to have a small heap of wetted clay handy at the pig machine trough together with the long handled shovel already referred to, and for this operation such simple means have proven quite effective in the control of any situation arising from power failure.

Of a related nature is the handling of hot blast furnace and open hearth slag, which is usually carried in cinder cars. With the conventional thimble type of cinder pot the center of gravity is quite high and usually above the turning point of the trunnion ring, in which it is suspended.

The dumping mechanism mounted on such cars consists in most cases of a cylinder, actuated by steam or compressed air and when the slag is partly or entirely frozen, there occurs an overturning moment during the dumping operation, which has to be guarded against, to avoid upsetting of the entire car.

This has usually been accomplished in the past by a separate control cylinder attached to the mechanism, functioning much in the manner of a door-check by forcing oil from one side of the piston to the other through orifices or valves at a rate of flow, controlled by the operator. In other types of equipment the compression side of the dumping cylinder is filled—prior to the start of the operation—with steam or compressed air, which acts as a cushion for the overturning moment of the pot. Either method depends on the judgment of the operator for its success and may therefore be classified as not foolproof. For this reason a twin or tandem cylinder arrangement has recently been introduced as the operating device for a 1200 cu. ft. cinder car, in which one cylinder acts as the power cylinder, while the other serves for braking purposes. It has been found, that through independent control of each side of these cylinders a gradual step by step pouring or dumping operation can be obtained, featuring almost the same accuracy as that heretofore available only with electrically controlled devices.

By L. F. WORDEN
Engineer, The General Electric Co., Pittsburgh, Pa.

Members of the A. I. & S. E. E. and guests: I do not feel that it is necessary to again review the progress of control developments for metal mixers, Bessemer converters and tilting open hearths. The previous speakers covered this field very completely in their papers. However, I would like to offer some comments on the papers in general and also offer some general comments on the subjects.

Mr. Green in his paper offers a rather unique and simple control scheme for emergency handling of the equipments in question. The suggestion has been made that perhaps the control engineer in trying to interlock the electrical control to meet the exacting requirements on this type of equipment, has added too many extra contactors or control fingers. These extra devices would of course add additional sources of trouble. These possibilities are, however, remote and I do not believe the electrical manufacturers have added any unnecessary complications The storage battery and the two major contactors required in Mr. Green's scheme offer a very simple layout. In providing emergency dynamic braking schemes in this and other types of equipment in the mill and crane equipments, the spring closed contactor offers a simple and safe means of establishing the emergency circuit whether dynamic braking or emergency motor armature. Contactor coil failure cannot cause injury to the equipment.

Mr. de Fries' suggestion that perhaps the industry should study the possibilities of plugging the pouring spout in case of emergency should be considered to its full extent. Mr. de Fries also brought the subject of hot metal ladle cranes up. Crane controls have been laid out which have duplex controls on the bridge and on which a safety cell has been built in to the cab. With an equipment of this design the safety compartment is provided with a bridge master control which allows the operator to move the crane away from the scene of the accident. This offers an escape from the gas formed and may save a life or prevent an accident.

Considering the available motors and control for this type of service the present day mill motors are designed for just this class of work and I believe amply fill the requirements. Mr. Allen pointed out that in these departments in addition to the ordinary dirt accumulations there are excessive amounts of graphite floating in the air. This graphite when it settles on control parts and panels may prove very difficult to combat. This graphite accumulates and reduces the creepage and clearances provided on the control equipments and will often cause faulty operation of equipment due to grounds or shorts. Equipment of this nature should, I believe, be enclosed in heavy duty gasketed enclosures which will exclude graphite or separate control rooms provided to protect the equipment.

There has been some mention made of counterweighted mixers or open hearths and I gather from the discussion so far that these have not proved successful. However, I would like to offer some comments on a counterweight scheme which has been installed on a hot metal mixer.

This mixer has a tilt motion operated by two 75 H.P., 1 hr., 75 deg. C., 230 volt series wound motors with two individual reversing plugging and dynamic braking control equipments. For operation of the counterweight hoist there was provided a 25 H.P., 1 hr., 75 deg. C., 230 volt series wound operated from a non-reversing dynamic control which included an electrical set spring opened solenoid brake.

The hoist mechanism for the counterweight is connected through a planetary gear to the main drive of the mixer unit. In order to start the tilting motion of the mixer it is necessary for the operator to operate the counterweight hoist motor and place the weight in the up position where it is held by the electrically set brake. With the counterweight held in this position the tilt motion can be operated in either direction of travel at will. Failure of power, overtravel of the mixer, or operation of the dead man switch will release the spring open brake which will drop the counterweight and return the mixer to the vertical position. Dynamic braking is provided to cushion the mechanical strain imposed on the mixer when the counterweight comes to rest.

The steel industry has made rapid strides in accident prevention and any requirements necessary to insure safety in hot metal departments should be given the utmost consideration by the electrical manufacturer. It appears to me that where modifi cations of standard devices are necessary for this added insurance that certainly steps should be taken to provide these features regardless of cost. Thank you.

By R. J. HARRY
Engineer, Alliance Machine Co., Alliance, O.

One of the greatest contributions, to the Steel Industry, in the safe handling of hot metal was the invention of the Four Girder Ladle Crane by G. W. Shem, who, at that time, was Chief Engineer of The Alliance Machine Company. The advantages of this type of crane construction were so apparent that steel mill engineers insisted on this type of crane in preference to any type of crane previously developed, and today it is standard equipment in all modern steel manufacturing plants.

The first Four Girder Ladle Crane had a main hoist capacity of 45 tons and was installed at the Farrell Works of The Carnegie Steel Company. Mr. Frank McKee was Superintendent of the Electric Department at that time and Mr. William Lewis was General Superintendent. Undoubtedly the safety features made possible by this design had a great deal to do with the selection of the Four Girder Crane in preference to the two girder cranes of that period.

In ladle crane construction it is absolutely essential for the auxiliary trolley to move independent of the main trolley and to pass under the main trolley. In order to accomplish this operation with the two girder ladle crane it was necessary for the main hoist chains, or cables, to depend outside the main girders, and the auxiliary trolley usually was supported on the inside lower flanges of the main girders, which not only provided an inaccessible location, but made the repairing and maintenance a very hazardous job.

Owing to the location of the main hoist cables no footwalks could be attached to the main girders and as a result were not usually provided. This meant that in order to lubricate the crane it was necessary for the operator to walk out to the trolley over the cover plate of the girder, climb over the trolley and then continue over the cover plate to the end of the bridge. This dangerous trip had to be repeated in order for the operator to reach his cab. It is small wonder that lubrication was often neglected, and inspections postponed until breakdowns occurred.

Another result of the ropes depending outside the main girders was that two independent hoisting drums were required. These drums were usually driven from a single motor at the center of the trolley with a separate gear train for each drum. Failure of any single pinion, gear, shaft or cable resulted in a spill and frequently was the cause of fatal injuries to some of the workmen.

On account of the hoisting ropes descending from the drums 180 degrees from the drum pinion, the drum pinion shaft reaction was taken by the cap when hoisting, or resulted in the drum pinion shaft being located under the trolley frame where it was very inaccessible. This further resulted in practically doubling the load on the drum shaft bearing at the gear end of the drum.

When the Four Girder Ladle Crane was adopted many of the objections referred to above were immediately overcome. The first improvement manifested itself in safety footwalks installed on both sides of the crane, making it possible for the operator and repairman to get to all parts of the crane in perfect security. It also permitted the designer to locate the bridge motor at the center of the bridge span and thereby provided a more satisfactory drive. Another improvement made possible was the locating of the trolley wires, or bars, in an accessible and safe location. It was practically impossible to do this on the two girder type of crane and an examination of the safety records will show many accidents, some fatal, as a result of repairing trolley wires on the old two girder cranes. When these breakdowns occurred with a ladle of hot metal on the hooks, the hazard was further increased.

On the two girder ladle crane it was necessary to locate the operator's cage between the girders thereby restricting the movement of the auxiliary trolley, or on the outside of one girder which limited the cross travel of the main trolley. In either case the operator's life was jeopardized when the pouring platform was located under the cage, and a running stopper necessitated jumping moulds.

On the Four Girder Ladle Crane the cage is supported from one of the main girders and as a result the cross travel movement of the main and auxiliary trolleys are not restricted in any way. With the development of larger ladle cranes requiring larger motors and magnetic controllers, the size of the operator's cage has increased immensely and today a modern cage is as large as a three room house and is provided with safety compartments, quick means of escape, and all apparatus conducive to safe operation. These improved conditions could not have been brought about if the Four Girder Ladle Crane had not been developed.

Full advantage of the possibilities for improvement in the design of the trolley on Four Girder Ladle Cranes was not immediately taken advantage of and it was not until several years after the advent of the Four Girder Crane that the Interlocking Drum was developed by E. H. Kendall of The Alliance Machine Company.

The first cranes of this design were installed in the Edgar Thomson Steel Works of the Carnegie Steel Company, the design being approved by Sydney Dillon, Chief Engineer, and E. E. Friedlander, who was Superintendent of the Electric Department, at that time. With this design the failure of any shaft or gear did not result in the dropping of the ladle as was the case with previous designs. The Interlocking Drum Crane also permitted close approaches at both ends of the crane with the ladle hooks, thereby conserving building space.

The Alliance Machine Company's next contribution to the safety of Ladle Crane operation was the patented Synchronized Double Motor Worm Driven Interlocked Drum Gear main hoist which was developed by E. H. Kendall. With this drive mechanical synchronization of the two hoist motors is obtained, and the load on the gearing exactly equalized. It further results in the elimination of the undesirable ratchet gears. With this closed system of gearing it is not necessary to locate the gears and pinions accurately on the shaft relative to the keyways to insure proper tooth contact as the flexible couplings on the synchronizing shaft connecting the worms afford micrometer adjustment. Owing to the fact that no jack shafts are used the brakes are located on the worm shafts where they are much more effective and provide the maximum of safety. Most ladle cranes of this type are equipped with two brakes (each capable of handling the full load) and are perfectly safe when thus operated. Four brakes are sometimes used, however.

The installation of more brakes than are necessary to hold the load on the synchronized worm driven interlocked drum gear main hoist simply adds to the safety of the crane, whereas with the spur driven interlocked drum gear main hoist, the installation of more brakes than are necessary to hold the load results in inertia stresses being set up when the brakes on the two motors do not set equally. The magnitude of these stresses varies as

the difference between the brake torque required to hold the load and the retarding torque of the brakes. When this difference becomes of sufficient magnitude as to overstress the hoisting mechanism it is advisable to install a device which is positively engaged in the hoisting direction and will permit free running of the motor and jack shaft in lowering. No doubt the added safety that can be built into the worm drive construction accounts for its adoption by almost all steel mill engineers.

An ingenious coupling has been devised which enables the operator to disconnect one of the hoist motors by the removal of three cap screws. This requires only a very short time and in case of motor failure the load could be handled with the remaining good motor, with very little delay. Even under these conditions when lifting the full capacity of the crane the gearing and shafting is not stressed any greater than when two motors are employed as the two worms are driven through the synchronizing shaft by the single motor.

This is an added safety feature obtained only with this construction. When hoisting the full load with one motor on the spur driven main hoist the stresses are doubled on the shafting and gearing.

The first ladle crane employing the synchronized worm drive was installed in the open hearth plant of the Timken Roller Bearing Company at Canton, Ohio. A very interesting test was made on this crane to determine whether or not the unequal setting of the hoist brakes, or failure of one brake to operate, would set up inertia stresses in the hoist gearing. In order to make this dtermination the crane was operated at full load with the caps removed from the drum shafts and one of the brakes purposely disconnected. The test showed there was no tendency for the shafts to lift in their bearings.

Another interesting test in connection with the operation of the interlocked drum gears when used in connection with the synchronized worm drive showed that after four years of operation these intermeshing drum gears actually made no tooth contact. The same clearance obtaining between the teeth as when the crane was built.

These tests are significant inasmuch as they prove the soundness of the engineering principles built into this type of construction and establishes the fact that the synchronized worm drive hoist is the safest hoisting means that has been developed to date, and that any accessories added are detrimental rather than beneficial.

Since the brakes are located on the worm shafts the same safety is obtained in braking whether one or two motors are employed. This drive also provides sufficient space to locate the sheave wheels on top of the trolley frame where they are more accessible.

After securing the maximum safety in the hoisting mechanism and the bridge, it was only natural that attention should be given to the safety of the rope reeving. A system of reeving has been developed by D. Kendall and W. D. Keller of The Alliance Machine Company, which will prevent a spill of hot metal in case one of the ropes should break and increases the life of rope from three to five times that secured by the old method of reeving. The development of the rolled steel sheaves which are free from surface defects is another move in the direction of safety and will further increase the rope life. The first installation of this reeving was made at the Ohio Works of the Carnegie Steel Co. Mr. F. E. Kling being the Chief Engineer and the late B. W. Gilson, then Superintendent of the Electrical Department.

In the early ladle cranes the failure of ladle hooks represented one of the greatest hazards, and although the hooks were forged from the best steel obtainable, failures occurred too frequently. In seeking a solution for this trouble David Kendall, General Manager of the Alliance Machine Company, originated the novel idea of the Laminated Plate Ladle Hook. In showing the drawings of this hook to the steel mill engineers, they were all favorably impressed with the design, but it was not until several years later that Mr. L. Holmboe, Chief Engineer, Illinois Steel Company, South Chicago, authorized the installation of the laminated ladle hooks on ladle cranes. The safety of this type of hook was so apparent that in a few years practically all other types of ladle hooks had been replaced.

It was during the building of the Aliquippa Works of the Jones & Laughlin Steel Corporation that two 150-ton, 4-girder, Interlocked Drum Gear Cranes were installed. Mr. Frank McKee who was Superintendent of the Electric Department specified that these cranes should be equipped for dynamic braking and the Alliance Machine Company is proud of the fact that they were privileged to work with Mr. McKee in the pioneering of this idea. These were the first ladle cranes equipped for dynamic braking and their successful operation marked another forward step in the march of safety. Today practically all ladle cranes are equipped with dynamic braking control and as a result loads of any capacity can be handled with perfect safety, at any desired speed. It also reduced maintenance costs and simplified the mechanical construction by eliminating the troublesome mechanical load brake.

In an article appearing in a magazine about six years ago Mr. W. H. Purcell was asked what the crane of the future would be. His answer was the worm driven crane, and today the Four Girder, Synchronized Worm Driven, Roller Bearing and Laminated Hook Ladle Crane, with dynamic braking control and safety rope reeving is the answer to that prediction, and in the construction of the three 275-ton Ladle Cranes for the Republic Steel Corporation, which, to the best of our knowledge, are the largest ladle cranes ever built, all of these features were incorporated with the addition of equalized hydraulic foot brakes. This construction provides every safety feature which our 30 years of steel mill experience has shown to be necessary without introducing any questionable compromises.

By H. W. BALL
▲ Assistant Chief Engineer, The Morgan Engineering Co., Alliance, Ohio

Having decided on the capacity and type of crane required, the next important feature of this prevention, is to purchase the crane from the manufacturer, to be built in accordance to specifications which require ample safety factors and safety features.

When the crane is finally put in operation, the most important measures to be taken, are the daily

inspection of the cables and brakes; careful maintenance of all moving and wearing parts.

The main trolleys of such cranes are usually designed with interlocking drums and two independent motor drives. In case of emergency one motor is capable of handling the load. These drives are equalized with what is known as a ratchet gear, located on the drum pinion shaft, the introduction of which was one of the most important improvements in recent years for the prevention of spills.

On all interlocking double drum ladle cranes, which are driven by two separate hoisting motors, it is likely to happen that the brake on one motor will set quicker than the brake on the other, at which time the force exerted by the free motor, would have a tendency to lift the drum next to the free motor from its bearings, thereby breaking the bolts holding the drum shaft caps in place. Should these drum shafts caps and bolts be made so strong that they would not break, it would simply put extra strain on the gearing or some other part of the hoisting machanism. Probably even greater danger comes from one motor getting current before the other, which would have the same effect so far as the action of the drum is concerned, as it would thereby be necessary to accelerate the motor which did not get current by the motor which did, thru the train of gearing. This acceleration causes a severe load on the gearing and other parts. This matter is a very serious one with cranes of this kind and there have been numerous cases where very serious accidents have been narrowly averted due to these causes.

The hoisting train from each motor contains a ratchet gear, which allows each motor to hoist the load and under normal conditions both motors to take an equal share of the load. If at any time there should be no current in Motor No. 1, Motor No. 2 will hoist the load by itself and the ratchet next to Motor No. 1 will "click," thereby doing no damage. This clicking makes considerable noise, which will call the operator's attention to any bad conditions in the adjustment of his brakes or of the electrical connections.

In lowering, the lifting beam and hooks are heavy enough to overcome the friction of the train of gearing, and should one motor get an excessive amount of current, it would click the ratchet on its particular train of gearing, as in doing **down** the slow moving motor controls the speed of the load, while in **hoisting** the faster moving motor controls the load.

We have placed this device on many cranes of this type, and in every case it has given satisfaction and absolutely prevented any danger from the sources enumerated.

There should be an ample safety factor in each train of gearing of at least 8, and the safety factor in the ropes should be from 8 to 10: Extra flexible rope with sheaves of ample diameter and preferably with wire rope center should be used. There are two sets of ropes of these cranes—each consisting of two separate pieces; one end of each rope in the set will be clamped at the end of the hoist drum and the other end to an equalizing beam located either in the ladle beam or in the trolley frame, according to whether the rope ends in the upper or lower sheave support.

The equalizer beam is provided with stops so that if one of the four ropes should break, the remaining three ropes will carry the load. The shock may be absorbed by the elasticity of the ropes themselves, which will ordinarily take care of any shock incident to this condition, but additional provision for this may be made if desired.

Rope sheaves in most cases are made of steel castings, and in a few cases they have been made of manganese steel castings, which have proven very satisfactory and with the use of sheaves of this material cables have shown very little wear.

The lower sheaves should be supported in a substantially built lifting beam, which also carries the ladle hooks, and is provided with a heat shield which protects the main part of the beam from the heat of the molten metal and structural guards for protecting the sheaves and ropes. Practically all the ladle crane hooks at the present time are made of laminated plates rivetted and welded. We have found that it is necessary to locate the rivets an ample distance from the edges of the plates. No rivets must be located in close proximity to the eye at the upper end of the hook. The plates at this end are held together by welding. There is considerable wear on the nose of the hook, which is protected by a wearing piece welded around the nose and a replaceable bushing is provided for the trunnion seat and for the supporting pin.

The front of each hook above the trunnion seat is provided with a wearing plate for taking the blows when the hook is brought into contact with the trunnion. Latches may be mounted on the sides for locking the ladle when suspended in the hooks. These latches fall into slots in the ends of the trunnions by gravity for preventing spills.

We make these hooks of open hearth steel plates of the following specification and analysis:

Tensile strength	60,000# per sq. in.
Yield point	30,000# per sq. in.
Elongation	22%
Reduction in area	30%
Phosphorus not over (Basic)	.06% (Acid) .04%
Sulphur not over	.05%

A pull and fatigue test of each plate of the hook is made and a report of same filed in our office record.

There is also an auxiliary trolley, which operates underneath the main trolley, for tilting the ladle, and in some cases this trolley is provided with special double tilting hooks, facing either way, for tilting the ladle in either direction.

The bridges for these trolleys are very substantially built with ample safety factor, and usually are supported on what is known as 16 wheel construction with compensating type of trucks. Equalizing beams are of heavy rolled steel construction, mounted directly under the girders, with both trucks and equalizers free to swivel on forged steel pins.

These cranes are equipped with double bridge drives, having the gears enclosed either with welded cases or cast gear boxes; ample footwalks, stairways and other safety features. Trolley is also provided with ample footwalks and steps provided from main bridge girders to these walks.

The cage of the modern ladle crane is very elaborate. In order to accommodate all the electrical equipment required, it takes several stories, and

sometimes two cages are provided, one under each girder and connected by a walk.

Hardened track wheels and hardened gears help to prolong the life of these cranes.

The hoists of both trolleys should be equipped with limit stops of a reliable type, mounted where they can be easily inspected.

The stopping of these bridges can be controlled with either the pull type mechanical, hydraulic or air operated brakes.

By W. E. WALDRON
Electrical Engineering Dept., National Tube Company, McKeesport, Pa.

SCOPE

1. DESCRIPTION OF MIXER
   - A—Capacity
   - B—Tilting Mechanism
   - C—Mechanical Stops
2. CONTROL EQUIPMENT
   - A—Control Panels
   - B—Master Controller
   - C—Dead Man Master
   - D—Traveling Nut Limit Switches
   - E—Crane Type Limit Switches
   - F—Signal Lights
3. FLOATING PLATFORM
4. EMERGENCY POWER
   - A—Air Engine
   - B—Air Supply
5. OPERATING
   - A—Conditions for Pouring
   - B—Emergencies

1—DESCRIPTION OF MIXERS

A—At the National Works of the National Tube Company there are installed two (2) Hot Metal Mixers each having a capacity of 800 Tons.

B—The Tilting Mechanism for each Mixer consists of two (2) self-locking screws (one on each side of the Mixer) which are driven by a single line shaft through Bevel Gears. On this line shaft are three (3) separate gear units, one for an Air Engine and one for each of two motors. These motors are rated at 110 H.P. (30′—75°) 230 Volts, D.C. Series Wound and are ordinarily operated in parallel but either of which have sufficient capacity to operate the Mixer alone. Because of the self-locking feature of the screw, magnetic brakes are not required.

C—Two (2) heavy cast steel bumpers mounted on the Mixer are so arranged as to prevent overtravel in the upward direction in event of failure of all Limit Switches.

2—CONTROL EQUIPMENT

A—The control equipment for each Mixer consists of two (2) full magnetic reversing, plugging panels with the necessary contactors to operate the two (2) 110 H.P. series wound motors in parallel, each motor having its own directional, accelerating and armatures shunt contactors. The main and control circuits of one panel are in no way connected electrically with main and control circuits of the other panel.

B—For each Mixer there is a double master controller which consists of two straight line, lever type, selective speed, master switches coupled together by a quick detachable coupling. This coupling can very readily be disengaged, thereby permitting individual operation of either master switch. These master switches also provide for opening both sides of the control circuit of the pouring directional contactors.

C—For each Mixer there is a double dead man master switch with gravity return handle. This master switch is equipped with one set of contacts for each control panel.

D—For each Mixer there are two (2) traveling nut limit switches (one for each control panel) arranged to provide slow down and stop in the up direction and slow down and stop in the lower direction.

E—For each Mixer there are two (2) manually reset, crane type limit stops (one for each motor circuit) which provide emergency overtravel protection in the up direction by disconnecting the main motor circuit in two places independent of the controllers, and must be reset by hand.

F—For each Mixer there are two (2) signal lights, located in the operators pulpit, one light connected across the armature of each motor so as to notify the operator if one motor has been disconnected electrically without his knowledge.

3—FLOATING PLATFORM

For each Mixer there is provided a balanced floating platform approximately 24″ square, upon which the operator must stand when pouring. This platform is so arranged that when depressed approximately six (6) inches by the weight of the operator, a mechancial device consisting of a pawl and rack is released permitting free movement of the Mixer in the pouring direction, this movement of pawl closes a hatchway switch which will then permit the movement of the Mixer electrically, in the pouring direction. The movement of the Mixer in the upward direction is independent of the position of the pawl or hatchway switch.

4——EMERGENCY POWER

A—For each Mixer there is installed a non-reversing air engine. This engine is mounted on a movable base that is tilted when air is admitted to the engine. The tilting action of the base causes the air engine pinion to mesh with a gear on the Mixer Drive and is locked in mesh with a manual reset latch. This action can be accomplished successfully with the Mixer in motion or at rest. When the air engine pinion goes in mesh, it opens a hatchway switch which prevents movement of the Mixer in the pouring direction until the air engine has been disengaged which must be done by hand. The Mixer can, however, be moved in the upward direction without damage to the air engine or other

equipment. The closing in of the air engine is entirely automatic or can be performed manually by the operation of an air valve within easy reach of the operator.

B—For both Mixers an Air Storage Tank with a separate motor driven air compressor is provided. Ordinarily the air storage tank is supplied with air from the Mill Air System through a check valve. However, if the Mill Air System Pressure falls below a predetermined value (90#), the check valve will close shutting the Mill Air System off the Storage Tank and at the same time starting the Storage Tank Air Compressor.

5—OPERATING

A—Conditions for Pouring.

1. Air Pressure at the predetermined value (90# or above).
2. Air Engine Pinion must be disengaged.
3. Crane Type Limit Switch Set.
4. Floating Platform Depressed.
5. Dead Man Master Switch held in operating position.
6. Operator moves the Main Master Switch in the Pouring direction and the Mixer tilts at a speed determined by the Master Switch position.

B—Emergencies

1. Assume the Mixer to be at rest in the upright position and the Air Pressure on the Storage Tank drops below the predetermined value. The electrical control will be locked out and the Mixer cannot be moved until the pressure on the storage tank is brought back to the required value.
2. Assume the Mixer to be in motion, pouring, and the following emergencies arise.
   (a) The air pressure on the storage tank drops below the predetermined value. The Mixer will be automatically returned to its upright position by the electric motors regardless of the position of the Master Switches.
   (b) Failure of electric power or tripping of one overload relay on each motor panel. The Mixer will be returned to its upright position automatically by the air engine.
   (c) A simultaneous failure of air supply to the storage tank and electric power occurs. The air engine will engage and by virtue of the air stored in the tank will move the Mixer in the upward direction a sufficient distance to raise the Mixer spout 24 inches.
   (d) Operator steps off the floating platform without releasing dead man master switch, Mixer wil come to rest immediately regardless of the position of the other master switch.
   (e) Operator releases dead man master switch, Mixer will immediately return to its vertical position at maximum speed with slow down and full limit features regardless of the position of the other master switch.

By H. S. RICHARDSON
Engineer, The Electric Controller & Mfg. Co., Cleveland, Ohio.

The handling of hot metal is probably the most hazardous operation in the steel industry, and there has been a gradual development in the devices and the equipment for this work during the past twenty years.

In the early period of development of electric drives for hot metal equipment we heard of an occasional spill, although some of these occurred on the old hydraulic mixers. Undoubtedly, there were minor spills which we did not hear about, but even those were a source of great concern because they indicated the presence of the hazard and predicted the possibility of a serious spill. Consequently, there has been a constant demand from the steel industry for additional safe-guards.

Many spills could undoubtedly have been prevented by cool-headed judgment on the part of the operator and by proper use of the apparatus at his disposal, but self-preservation is human nature and usually the operator flees at the first alarm. Therefore, the ultimate safe-guards for the prevention of spills must be designed on the basis of proper operation without human direction.

Next to the direct and vital interests of the steel plants themselves, the subject is of greatest importance to the control manufacturer rather than to the builders of the mechanical equipment or to the builders of the motors, because in case of incorrect operation after an equipment has once been in satisfactory operation, the finger of suspicion always points at the control because it is the medium through which the motors and mechanical equipment are operated.

I shall confine my discussion to Metal Mixer control as I believe that will include all essential features connected with Bessemer Converters and Tilting Open Hearth Furnaces. Also I shall refer only to 2-motor drives because it is the broader subject and it is obvious that single-motor drives may have the same features except the ability to operate in case the motor or control is disabled.

Our Company has been intimately associated with the development of control of this character from the time that electric drives were first applied, and has pioneered the major improvements described in this discussion.

Contrary to most steel mill applications the service is not severe, but the vital requirements are dependability, continuity of service and safety.

I believe that an understanding of the present-day equipment can best be obtained by reviewing briefly the history of the development of this type of control.

The first electrically driven Mixers were equipped with series brakes, and we furnished the control which consisted of a single magnetic controller of the duplex type with a single, standard master for operating the motors in series "pouring" and in parallel "return". Two ordinary hatchway limit switches connected in the control circuits were used for limiting the travel in both directions, and knife switches were provided on the board for cutting out

either motor, which knife switches automatically transferred the brakes to the circuit of the active motor. This was early in 1913.

In July of the same year a Mixer was furnished without brakes, and a separate magnetic board was provided for each motor, the two boards being operated from a single master but with an auxiliary master to provide for either series or parallel operation. Also, a complete spare control equipment was provided for emergency and this was independent of limit switches.

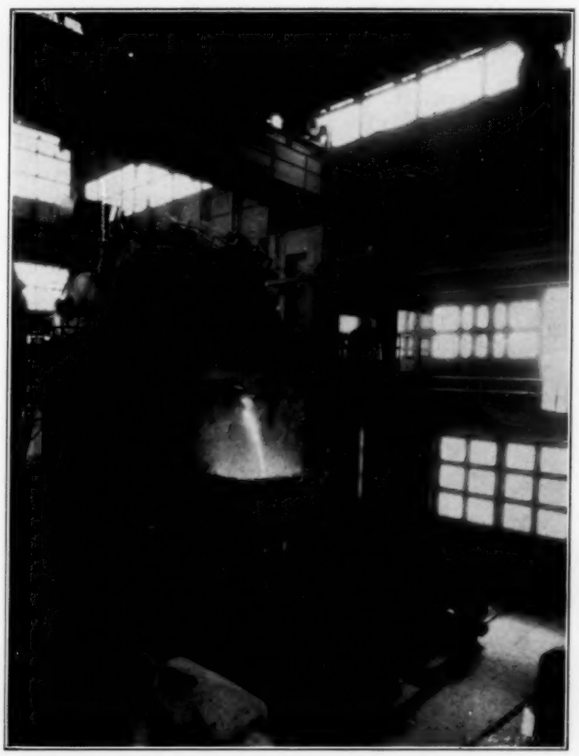


FIG. 1—Mixer Shown in the Process of Pouring.

Also, in 1913 there was another Mixer with brakes and with the motors connected permanently in series but no means was provided for operating with only one motor; this was really a step backward but was specified by the customer. However, on this installation appeared the first device for compelling the operator to be at his post in order to "pour". This device consisted of a Youngstown Safety Limit Stop used merely as a main circuit safety switch in the "pour" direction, and the operator had to stand on a lever in order to close this switch.

In 1915 a separate spring-return master was used for each magnetic board, the two masters being coupled together by a quickly and easily detachable coupling. This provided entirely separate control for each motor, in both main and control circuits, and permitted the operation of the two motors individually or in unison; if the operator left his post the spring-return on the master switches stopped the Mixer. Also the hatchway limit switches were replaced by a more rugged type, although they still remained spring-return.

In 1917 the limit switches were made with gravity-return, which is far more dependable than spring-return; this was important because some accidents were caused by limit switch failures.

In 1918 the first application of the "dead man's" master was made. This was an auxiliary master with spring-return which the operator must hold in the "pour" position in order to operate the motors in the "pour" direction from the normal master; if he releases the "dead man's" master, leaving the normal master in any running position (either "pour" or "return"), the Mixer returns to the upright position.

However, if he centers the normal master and releases the "dead man's" master, the Mixer remains at rest. This enables him to use both hands for weighing and for clearing slag out of the spout.

The "dead man's" master is mounted overhead to prevent the operator falling against it in case of illness or accident and thus preventing its proper functioning.

This Mixer had series brakes, and a special scheme of connection (devised in 1916) was used to connect them in the main line to both controllers in order to retain the feature of being able to operate with one motor and controller without the necessity of throwing any transfer switches. The brakes for this method of connection must be designed to release on the current of one motor and also must be able to withstand the current of both motors in normal service.

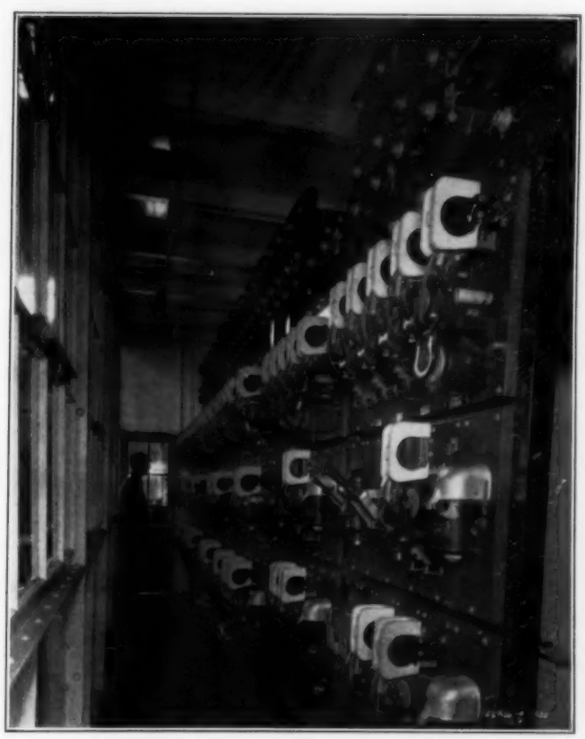


FIG. 2—Time Current Control Panels for Mixer Shown in Fig. 1.

In 1923 the "dead man's" master was modified so that if it were released, the Mixer would return to the upright position irrespectively of the position of the normal master; the customer, in this case, maintained that it was not safe to let the Mixer remain at rest if the operator left his station be-

cause a stream of several inches depth would spill enough metal to cause serious damage. This meant, of course, that the operator had to do the weighing with one hand or else they had to have another man for that duty as well as for clearing the spout of slag.

The "dead man's" master was equipped at this time with gravity-return. Also the control circuit limit switches were provided with two contacts in parallel for each circuit in order to guard against the possible loss of a contact vital to the stopping of the Mixer.

On the same installation, the Youngstown Safety Limit Stop was first applied as a main circuit, final limit switch to stop the motors independently of all control circuits; this has been a standard feature since that time. In the majority of installations this limit switch simply opens the power circuit, but it has also been arranged to provide dynamic braking in the same manner as on a crane hoist with which I assume you are all familiar. The Youngstown Stop may be applied to either or both limits of travel, but in any case it does not prevent a spill because at one limit the Mixer is upright and at the other limit it is empty. The purpose of this feature,

FIG. 3—Time Current Control Panels for Control of Open Hearth Tilting Furnaces.

therefore, is to safeguard the driving mechanism against damage due to overtravel, and in this way it contributes to the important requirement of uninterrupted service.

Up to this time little attention seems to have been paid to power failure, at least in the majority of cases. The subject always came up in the discussion of equipment, and a few installations were made with automatic or manual transfer panels to transfer the control to a spare feeder line; but the usual reply was that power failure occurred so seldom, and even then for such short durations, that it did not warrant the expense of providing for that contingency.

In the last few years, however, this phase of the problem has received more attention. Several years ago I made the suggestion of counterweighting the Mixer and using a controller somewhat similar to a dynamic braking hoist controller, but I learned that the counterweight scheme had been tried with rather disastrous mechanical results; however, I am not yet fully convinced that such an arrangement is impractical.

In 1928 we furnished an equipment in which a storage battery was utilized for emergency return in case of power failure. A manual controller of the Dinkey type was connected in such a way that with the handle of this controller in one direction from center, the Mixer was controlled in the usual way from the regular magnetic control and the power line; in case of power failure or trouble of any kind with the magnetic control the operator reverses the Dinkey controller which entirely divorces the magnetic control and operates the motors in the "return" direction from the battery; he does not have to exercise any care in manipulating the Dinkey controller but can throw it to the full-on position since a permanent resistor protects the motor from excessive overloads and also limits the drain on the battery. The equipment could have been arranged to automatically throw the motors over to the battery on power failure but the arrangement decided upon also took care of trouble with the magnetic control, and by putting the Dinkey controller in a protected location the customer felt the operator could be depended upon to take care of the power failure condition.

We have furnished a number of equipments for Metal Converters in Canada where storage batteries are used for "return" in case of power failure, the transfer being automatic; later installations employed A.C. motor-generator sets with large flywheels for supplying the D.C. power, the M-G sets being so designed that in case of A.C. power failure the stored energy in the flywheel is sufficient to provide D.C. power long enough to return the Converters to the "safe" position. These Converters, however, are comparatively small and probably storage batteries or special M-G sets large enough for modern Mixers and O.H. Furnaces would be prohibitive in cost.

A device that has appeared within the last few years as the solution of the automatic return in case of power failure is the air engine, and it appears that this is being adopted quite generally.

At the time of writing this discussion I assume Mr. Allen will explain the mechanical features of the air-motor drive. As far as its control is concerned, it may be brought into action automatically on power failure or may be applied by the operator, or both, depending upon the types of air valves used.

Control that we have furnished for installations using the air-motor return includes an interlock whereby the Mixer cannot be tilted unless the air pressure for the air-motor is above a predetermined minimum. It also includes another interlock which causes the electric control to be disconnected if the air-motor is brought into action, whether this is done by the operator or automatically by power failure. The object of this latter interlock is to prevent the application of the electric motors and the air-motor at the same time since the former may be applied to tilt the Mixer while the air-motor always drives in the "return" direction; but so far as we have been able to determine, this does no actual harm and, consequently this interlock may not be considered really essential.

On most installations the gear for the air-motor drive has been attached permanently to the Mixer drive and rotates at the same speed as the electric motors; the air-motor with its pinion is disengaged

until the application of air tilts it so as to cause the pinion to mesh with the gear.

This arrangement of the air-motor also adds another problem, namely, increased drift due to the added flywheel effect of the gear which is quite large and must necessarily be heavy and rugged to withstand the severe treatment to which it is subjected.

Hot Metal Machines are always over-motored to some extent, and properly so, to insure operation with one motor alone; but in many cases the customer has specified even larger motors than those recommended by the machinery builder simply from the standpoint of reduction in the number of motor spares. This excessive over-motoring aggravates the condition of drift because the series motors, which is the type almost universally used, attain in excessive speed and the large, heavy gear for the air-motor rotating at this speed constitutes a very conderable flywheel effect.

Brakes have been unnecessary on usual types of Mixers and O.H. Furnaces for the past seventeen years, but with the arrangement of air-motor just described and the resultant possibility of excessive drift it apears very probable that brakes will be necessary; and the problem of the brakes themselves is not as simple as formerly because they must be combination electric and pneumatic brakes since it is necessary to release them by air in the case of power failure.

Therefore, I think that the electrical departments of the steel industry should consider this point very carefully before specifying motors in excess of the size recommended by the machinery builder.

A few years ago the electrical engineer of one of our largest steel plants told me that all he had on his Mixer was a Dinkey controller, that he had never had a spill nor any other serious trouble and, consequently, that he saw no use of complicating the control. However, his Mixer is a small one (150 or 200 tons) with a single-motor drive, so that his control cannot be taken as a criterion. Nevertheless, his statements cause one to pause and consider whether or not the control is being carried to such a degree of elaboration that it is getting to be a hazard in itself.

I think the most convincing answer to this is the fact that all the present-day features which we consider to be essential were designed to meet actual conditions in the steel industry and have been put to the test thoroughly in actual practice for a number of years. Frankly, we are as anxious as anyone concerned to keep the control as simple as possible and we bend our efforts in that direction.

In this connection I can say that certain features, such as manual or automatic power transfer panels, have been added to meet local conditions of certain plants. Other features, such as emergency manual operation and opening both sides of the line to all control circuits, have been added to meet individual plant preferences.

Looking back over all the various equipments we have supplied, it is obviously impossible to settle on a standard control that would meet all local plant conditions and individual preferences. The best that can be done, I think, is to lay down a few essential requirements, and the following are based on the present application of the air-motor emergency return.

(1) Entirely separate control, in both main and control circuits, for each motor.

(2) Ability to operate with either motor or with both motors, without the use of transfer switches and without the necessity of the operator leaving his station.

(3) Control circuit limit switches of the engagement-type with gravity-return for the normal stopping limits in both directions; these limit switches to have two contacts in parallel for each circuit. Engagement-type limit switches are preferable because they are actuated directly by the mixer body.

(4) Main circuit limit switches for final limits in both directions, these to function independently of all control circuits.

(5) A "dead man's" master with gravity-return, or its equivalent, arranged so that the Mixer will return to the upright position if the operator leaves his station, irrespectively of where he leaves the normal operating master.

In a few installations the extra "dead man's" master has been eliminated by equipping the normal master with gravity-return to the first or second point in the "return" direction. From the operator's point of view I do not see that it makes any difference which scheme is used since in either case he has to **hold** one master in a definite position against gravity in order to keep the Mixer at rest in any intermediate position between the two limits.

It is my opinion that the separate "dead man's" master which has simply two positions and a small "throw" and with positive stops for each position, is more dependable than a master with gravity-return to an intermediate operating position; also less manual effort is required of the operator.

(6) Means for disconnecting the control circuits from the opposite side of the line to that connected to the master switch; this being a protection against grounded circuits.

To open both sides of the line to each and every circuit on the master complicates the design of the master and increases its cost considerably, and I believe the results obtained are not warranted. It should be, and has been entirely satisfactory to open the common return of all control circuits by means of an auxiliary master or safety knife switch located at the operator's station and, if, desired, additional such devices located elsewhere.

(7) An electrical interlock with the air supply for the air-motor so that the Mixer cannot be tilted with the normal motor drive unless the air pressure is above a predetermined minimum; but the "'return" direction of the motors must be independent of this interlock.

(8) Series Brakes, having both magnetic and air release, where there is any possibility of an overhauling load or where the size of motors and load conditions may result in excessive drift. Various means of slow-down and dynamic braking have been carefully analyzed and considered, but brakes seem to be the simplest and most satisfactory solution.

By J. A. MORGAN
Electrical Superintendent, Carnegie Steel Co., Edgar Thomson Works, Braddock, Pa.

I enjoyed these very able papers immensely tonight. The motors that are built today are so much better than they were thirty years ago when we were operating the first motor driven mixers, and the improvement in control is so great that there is very little trouble operating any of them compared with what there was. Instead of the additional motor, I believe the same thing will be accomplished by some means of shutting off the stream at the spout rather than attempting to tip the mixer back.

By J. W. BENNER
Superintendent of Employment, Carnegie Steel Co., Munhall, Pa.

I enjoyed this meeting tonight very much. At our Homestead plant, we have two hydraulic mixers and one electrically operated mixer. On the hydraulic mixers we extended the lever of the operating valve through the fulcrum and put counterweight on it so that the operator pushes the lever down to operate his mixer and as soon as he takes his hand off the lever the valve goes into reverse position and reverses the mixer.

On electrical mixer we put an air engine and it works very successfully, but our open hearth men did kick against it, because they want the mixer to reverse at the same speed as they pour. When pouring and ladle nearly full and electric power cut off, they would spill a lot of iron before the mixer would reverse and shut off its flow; so we suggest to the men that build mixers that if they install auxiliary power to reverse mixer, that mixer reverse at same speed as when pouring.

By F. P. TAUGHER
Control Engineer, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

There are several points, which I have in mind, that I believe are worthy of consideration.

One, is regarding a mixer control, built recently, on which we may have gone a little farther than on any so far mentioned this evening. Instead of a double control this was a double duplex control; each control was designed for the operation of two motors. Each controller was equipped with a separate master and a separate set of limit switches on the mixer. The motors were selected by two small hand operated switches with vertical handles. With both handles thrown forward the motors run on controller No. 1, with both handles thrown reverse, both motors run on controller No. 2. With one handle forward and one reverse, a motor can be run on each controller. In addition to the advantages already discussed this evening, this arrangement permits both motors to be run on the second controller in event of the first control failure, and also allows one motor and brake to be disconnected from the line completely. Under either condition no brake drag will be experienced.

The other idea that I believe has possibilities is this; the use of a fly-wheel M.G. set for power supply to the mixer drive. In case of power failure the fly-wheel driven set will have enough energy to return the mixer.

Using the fly-wheel principle, there is another method of obtaining a stored energy return. A small D.C. motor with fly-wheel attached can run idle on the same bus with the mixer equipment. At low voltage, say 5 or 10%, above the dropout value for the control apparatus, or approximately 200 volts on a 230-volt circuit, a low voltage relay could operate and segregate the mixer bus from the main bus. The D.C. motor would then become a generator and the stored energy of the fly-wheel would return the mixer.

At first thought it may seem that the amount of stored energy would necessitate large fly-wheel equipments; however, I would like to refer back to a statement Mr. Allen made, when he brought to your attention that the mixer had only to return 24" to cut off the stream of flow.

By P. B. HARWOOD
Engineering Department, Cutler-Hammer, Inc., Milwaukee, Wisc.
Read by T. S. Towle, Pittsburgh, Pa.

In selecting the electric equipment for any device which handles hot metal, the primary consideration is safety. The equipment should be arranged so that it will be as reliable as is possible, and at the same time arranged so that in case any trouble does develop, the apparatus will assume a safe position.

In order to insure that power will be available to move the mixer to a safe position in case motor trouble develops, it is customary to equip the mixer with two motors which are normally operated in parallel, but which are arranged so that should trouble develop on one of them, that one can be disconnected and the other one will have sufficient power to return the mixer to its safe position. The control apparatus supplied for the two motors is generally entirely independent, that is, separate contactors and relays and separate resistance are used. Therefore, with this arrangement, if any trouble develops on the control equipment for one motor, that complete equipment may be disconnected and the mixer returned to a safe position by the other equipment.

It is customary to supply two master controllers, each of which handles one of the motors, the electric circuits of the two being entirely independent. For easier operation, the levers of the masters are mechanically tied together. A simple way of arranging masters this way is to extend the shafts and mount a latching device on the extensions. With this arrangement it is only necessary to press the latch and slide it out of position in case it is desired to operate one master independently. Some times the master controllers are arranged with centering springs so that in case the handle is released, the master will return to the off position. It is also customary to provide the control equipment with an auxiliary master, which is smaller than the main masters and which must be held in the on position as long as the equipment is running. This master is usually mounted overhead and is provided with a weighted handle so that in case the handle is released, the master will be returned to the off position. The control circuits are then arranged so that if the auxiliary master is returned to the off position, the

mixer will be started in the return direction, and will be brought back to the full upright position automatically. An auxiliary master control of this type is usually known as a "dead man master" since it provides for safe return of the equipment in case anything happens to the operator. Of course, it also insures that the operator remains at his position during the tilting of the mixer.

Dynamic braking is frequently provided for mixer equipments in order to insure proper stopping, but in many other cases it is not required because of the fact that the mechanical efficiency of the equipment is so low that it will not overhaul. Magnetic brakes are sometimes used, and in some cases, air brakes. If such brakes are used, provision should be made for releasing them in emergency.

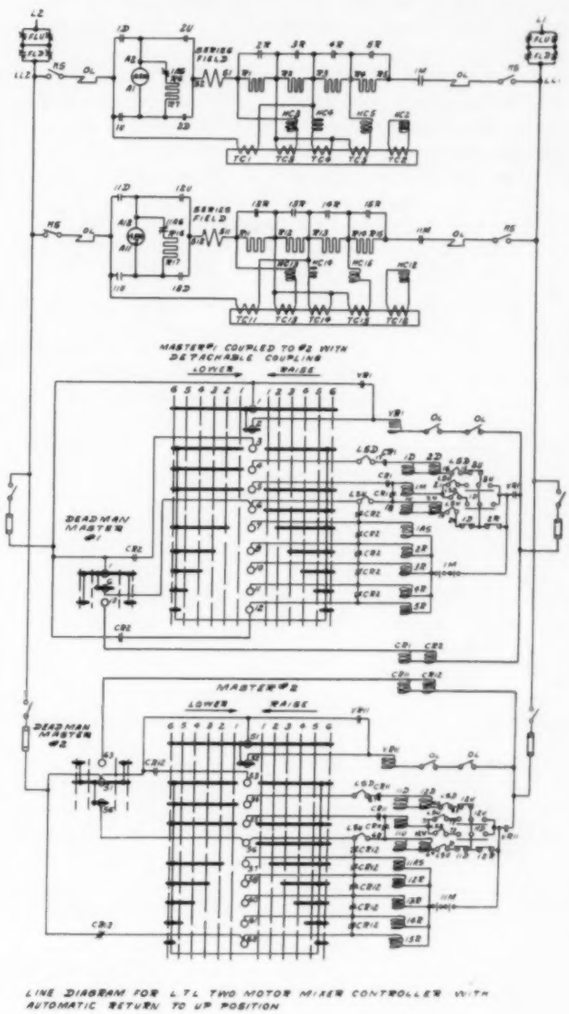
There seems to be some difference of opinion as to the amount of limit switch protection which is required. On some installations pilot limit switches are provided and it is customary to make these double pole and connect them in both sides of the direction contactor coil circuit. In addition to the pilot limit switches, main circuit limit switches of the same type as used on crane hoists are some times provided. As a further precaution, overtravel limit switches are installed on some equipments, these being of the pilot type in some cases. If of this type, they are simply arranged to cut off power from the control circuits of the magnetic panel. Some times main circuit overtravel limit switches are used, and in this case they cut off the entire power circuit from both motors and controllers.

Since hot metal in liquid state is being handled, it is essential that the acceleration be very smooth. Time limit acceleration with a sufficient number of steps is ideal for this purpose. In order to insure a smooth stop, it is customary to provide slowdown under control of the master. On this point of the control, the starting resistance is in circuit and an armature shunt is also connected to insure a steady low speed.

The conditions under which a controller for a mixer must operate, are not particularly ideal. There is a considerable amount of heat and dirt, and in particular, there is a large amount of graphite in the air. This graphite is very difficult to keep out of control equipments. There are also corroding gases present, and these have a tendency to cause trouble with any interlock fingers or light contacts which may be used on the control board. Insofar as possible, the controller should be shielded from the dirt and the gases, and should also be protected against any possible splashing of hot metal. If the control is located near the mixer, dust tight enclosures of a heavy type should be used. In particular, limit switches used on these equipments should be made as dust-tight as possible.

A number of mixers and other hot metal handling equipments have been equipped with magnetic control for the normal operating conditions, and with an entirely separate control for emergency use. In most cases, the emergency control is of the manual type, generally consisting of simple drum type controllers. A transfer switch is provided to transfer the main motor circuits over to the drum control in emergency. At least one equipment has been provided with an emergency control which is entirely operated by air, so that the mixer can be returned to the up position even if the entire electrical supply fails.

In a 2-motor mixer each motor is provided with



LINE DIAGRAM FOR L.T.L. TWO MOTOR MIXER CONTROLLER WITH AUTOMATIC RETURN TO UP POSITION

FIG. 1

its own set of contactors, resistors, and accelerating means. Either motor may be disconnected by opening its main line knife switch.

Two independent masters are provided, and their operating handles are mechanically tied together. The diagram shows two dead man masters, but actually these are simply two independent cylinders operated from one lever. The control feed to the main master is taken through an on position segment of the dead man master. With this master on the relays CR1 and CR2 are energized, closing the contact to the main operating master. From this master, six speed points in either direction are obtained. If at any time the dead man master is released, the mixer will be returned to the up position at full speed regardless of the position of the main master. In this case, release of the dead man master de-energizes the relays CR1 and CR2 and breaks the feed to the main master. At the same time a circuit is made through an off position contact of the dead man master to Finger 6 of the main master, and from there to the operating coils

of the up direction contacts. Down contacts on relays CR1 and CR2 provide the circuit to open the armature shunt contactor and to close the auxiliary contactor so that the motor is accelerated to full speed in the up direction and is stopped by the up direction limit switch.

The diagram shows double pole pilot limit switches in each direction, and also shows main circuit over-travel limit switches which are connected so that they cut off the entire circuit in case the mixer runs beyond the operating limit.

By JAMES FARRINGTON
Electrical Superintendent, Wheeling Steel Corporation, Steubenville, Ohio.

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There is one condition on ladle cranes that crane manufacturers have overlooked and due to which we had a rather serious accident. When tipping the ladle the craneman could not see the ladle was resting on the mixer, causing it to unhook and the ladle fell and burned a couple of men. They should, in that kind of work, put a lock hook over the trunnion of the ladle, so that in case it should rest on the mixer it will prevent the ladle from getting out of the hooks and causing a disastrous accident. Mr. Richardson mentioned about having a common return. We will not permit any common returns to be used. Any important operation should be protected by a double pole relay, especially safety devices.

By E. J. GOVE
Engineer, Cutler-Hammer, Inc., Youngstown, Ohio

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The question of safety in connection with hot metal handling equipment is becoming more and more important because of the increasing size and capacity of the equipment used. A 200 ton ladle crane carrying 100 tons of hot steel is a dangerous plaything and deserves the most careful thought in the design of the mechanical and electrical equipment.

Sometime ago we were asked to furnish control equipment for three 275 ton ladle cranes, the largest ever built up to that time. The bridge and main hoist were each driven by two 200 H.P. motors in parallel and the main trolley by two 45 H.P. motors in series. The two auxiliary hoists and the auxiliary trolley were single motor drive.

In connection with the double motor drives it was desired as a matter of safety and convenience to be able to easily and quickly cut out either one of the motors and control and run with the other. Following our standard practice we provided each of the parallel motors with a separate and individual control panel with a double master having two separate sections, one for each panel.

A push button station was installed in the operators cab for each bridge control and a double throw control knife switch was provided in the cab for each main hoist control so that either bridge motor or either main hoist motor and control could be cut out of circuit without leaving the cab.

Since the two main trolley motors were connected in series, only one control panel was provided. Two double throw safety switches were mounted directly on the trolley to be used for cutting out either motor.

A duplicate of the bridge control master was installed in a separate fire proof cab in one corner of the main cab and a transfer switch was provided for completely transferring all circuits from the regular master to the emergency master.

It was a comparatively simple matter to take care of single motor emergency operation of the bridge and main trolley and this was done without any complicated wiring. However, the emergency single motor operation of the main hoist involved the magnetic brakes as well as the motors and control. The use of transfer switches for transferring both brakes to either motor circuit was discussed but was turned down because the transfer could not be made from the operator's cab without complications. A double series winding was also proposed for each brake but the simplest solution seemed to be the use of shunt wound instead of the usual series wound brakes and this was finally decided upon.

Low voltage coils with a series resistor were used on the brake circuits; were arranged so that both brakes operated no matter which motor was disconnected. Although the use of low voltage shunt wound brakes is quite common on Ore Bridge Hoists I believe their use on a Ladle Crane Hoist is quite unusual. However, there seems to be nothing wrong with the idea providing the correct coil and resistance is used and it has worked out quite satisfactorily. Series brakes were used on the auxiliary hoists.

It was desired to limit the full load lowering speed to a lower value than the light hook lowering speed and this was accomplished with the standard control layout.

In addition to the special features, the dynamic lowering control provided the usual standard Inductive Time Limit features of 100 per cent of full load current through the brake on the first point, over 40 per cent current through the brake on all points, definite time limit acceleration, separate adjustment of hoisting and lowering acceleration, automatic time limit acceleration on the "kick-off" point, automatic time limit deceleration on all lowering points, graduated dynamic braking, etc.

Dynamic braking safety stops were used on all of the hoist motions.

The operation of the cranes was unbelievably smooth and except for a slight adjustment of the first two accelerators on the bridge boards to aid in taking the swing out of the ladle, practically no control adjustments were necessary.

We are particularly pleased with this installation because of the complete safety and protection it affords to both men and motors. We realize the extreme care used by the operating departments in the selection and maintenance of all equipment for handling hot metal and we try to co-operate by offering the best equipment we can design and produce.

By E. L. WINDENBURG
Engineer, Cutler-Hammer, Inc., Pittsburgh, Pa.

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Mr. Harwood mentioned that we had furnished a combined electric and air control for mixers. Two 800 ton mixers were involved each being operated by two 110 H.P. series motors. In an emergency one

motor is capable of operating the mixer. The air operation has been described by Mr. Allen.

The control is practically the same as that described by Mr. Towle except an additional air control panel is required. This consists of a pressure regulator and necessary operating relays.

In order to start pouring, it is necessary that:

1. Sufficient air be in auxiliary air tank.
2. The "Dead Man" master must be held in the "on" position.
3. The operator must be standing on the floating platform.
4. The "up" overtravel limit switch must be closed.
5. The air motor interlock must be closed.

With these conditions fulfilled, moving the operating master in the proper direction starts the "pour".

While pouring, the mixer will return to normal position electrically and automatically without operator's aid, if:

1. Air pressure should fall below a predetermined value.
2. If dead man's master is released.

Mixer will be returned automatically by air when:

1. Voltage fails.
2. Overloads for both motors trip.

Slowdown and stop are obtained by traveling nut —limit switches. If overtravel obtains in the "up" direction, a limit switch opens which opens both sides of the armature circuit and this limit switch must be reset by hand.

The operating master opens both sides of the "down" direction coils to prevent operation if a ground should occur.

We have also recently furnished Inductive Time Limit Control for three Open Hearth Tilting Furnaces each powered by two 110 H.P. series motors. Either motor can be operated individually and has sufficient power to operate the equipment.

Control is reversing plugging with armature shunt for slowdown and series brakes are used. Traveling nut limit switches are used.

Masters are of the spring return type and give several speed points in each direction. They are coupled together with a quick detachable slip coupling. For "slagging off" a separate set of masters located away from the pulpit, are used. A manual transfer switch is used to transfer control from the normal operating masters to the "slagging off" masters.

In addition to the above, control was furnished for three Converters each driven by two 110 H.P. series motors. Either can be operated as a unit and has sufficient power to operate the equipment.

This control is similar to the Open Hearth Tilt except no limit switches or extra masters were used. Control is reversing plugging with armature shunt for slowdown and series brakes are used.

All controllers are enclosed in floor type enclosing cases. These installations have proved to be satisfactory in every respect.

By C. P. CROCO
General Engineer, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

I have been asked to discuss the application of motors to hot metal mixers, Bessemer Converters, tilting open hearth furnaces and ladle cranes from the viewpoint of protective apparatus.

I do not think it necessary to make any discussion as to the merits of the electric drive as compared to the hydraulic drive as to operation and maintenance.

As has already been discussed it is the standard practice to apply two motors to mixers, either one of which is of sufficient capacity to operate the mixer. Each motor drives through an independent gear unit into the jack shaft carrying the bevel gears driving the worms or screws.

As in the case of the mixer the Bessemer converter is driven by two motors either one of which is of sufficient capacity to operate the vessel. In the case of the tilting open hearth, depending on the size, the electric drive usually consists of from two to four motors.

The hoist on most modern ladle cranes is motored with two motors each driving into interconnected drums. On ladle cranes used to pour ingots it is also the usual practice to drive the bridge with two motors so as to insure movement of the crane in case of a "running stopper".

These are the most common places in hot metal handling equipment where a failure of electric equipment might cause a spill. As has been pointed out, in every case, these applications are generally overmotored.

No one would think of using any other than a mill type motor on any of these applications. I would like to point out a few of the protective features that had led to the universal use of the mill type motor.

Because of the large amount of graphite and fine particles of metal found around all hot metal equipment makes it absolutely necessary to use an enclosed motor. Due to the danger from dirt and flying sparks the leads are brought into the motor through conduit and the mill motor is provided with a conduit box.

For inspection purposes the cover is provided with a covered opening over the commutator. The frame is split horizontally and hinged so that the top half can be raised for purposes of inspecting the armature. All connections between the windings in the upper half and the lower half of the frame are made inside the frame. No connections are made outside where they can be injured from hot metal or dirt. The bearing housings are clamped by special clamps and do not depend upon the upper half of the motor frame. Thus the upper half of the frame can be raised without effecting the alignment of the armature and all clearances can be checked.

In case of emergency when one motor is out of service or when the mechanism jams it is necessary that the motors be able to commutate very high currents. The mill type motor is provided with commutating poles to insure good commutation under these conditions. To insure good commutation on sudden changes of loads the commutating poles are laminated.

The commutating pole winding as well as the main pole windings are wound on steel shells. The pole piece is slipped into the shell and the pole and shell are clamped to the frame with the pole bolts. This insures a tightly clamped field coil at all times without the use of wedges or springs.

While the possibility of motor failure is remote it is necessary to be able to remove a motor without any delay in case of a failure. As every one knows, the space for the motor on any hot metal equipment is very limited. Therefore it is important that the holding down bolts be readily accessible so that a socket wrench can be used. The mill type motor is so constructed that holding down bolts can be reached with a long socket wrench.

I do not want to bore you with any more details as I believe that no one here will question that of all the electrical apparatus used on hot metal equipment the mill type motor is the most reliable.

By H. S. RICHARDSON
Engineer, The Electric Controller & Mfg. Co., Cleveland, Ohio.

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It was unfortunate that there was not sufficient time before the close of the meeting for further discussion by the authors of the papers. It was apparent to me from some of the discussions that some of the statements in my paper were not entirely clear and were evidently misunderstood; in order to keep within the allotted time it was necessary to eliminate description of details which would probably have clarified some of my general statements.

I am therefore, taking this opportunity to explain more clearly a few statements that may have been misunderstood.

In the first place, correction should be made of the statement in the early part of my paper that the first electrically driven mixers were installed early in 1913. This was in accordance with definite records which we were able to find, but after the meeting I learned that there was one electrically driven mixer installed about 1907 at the T. C. I. & R. R. Company and also one at the Edgar Thomson Works of the Carnegie Steel Company in about 1898, which I believe was originally operated hydraulically and was later changed to an electric drive. However, we have not been able to get any definite record of the electrical equipment on these two previous mixers.

Since the first part of my paper was in the nature of a history of the development, the statement referred to should be corrected to read, "The first electrically driven mixers of which we can find definite record," etc.

Mr. Worden commented on the fact that I seemed to be uncertain as to whether or not we ought to go back to a more simple form of control as supplied on some of the earlier and smaller mixers. I did not mean to inject any feeling of uncertainty into my statement that "the present development causes one to pause and consider whether or not the control is being carried to such a degree of elaboration that it is getting to be a "hazard." Each of the steps in the development of this type of control were added in response to the demand of the steel industry itself, and in the particular statement referred to the meaning was that as each of these steps were added they were carefully analyzed to make sure they did not add extra hazards; some requests have been made by the steel industry for certain features of control which after careful analysis proved to be either unnecessary or hazardous.

Mr. Farrington took exception to the statement regarding common return. The use of the term "common return" was undoubtedly misleading by reason of the fact that it is almost universally associated with the old system of using a common return in the main circuit for two or more motors on cranes and even other machines.

My statement referred to the control circuits on the master switch, pointing out that it should be and has been satisfactory to open only one side of the line to all the control circuits on the normal operating master, which is the usual arrangement on all magnetic control, and to open the other side of the line to all the control circuits by means of an auxiliary master as an emergency device in the case of a ground on the control circuits from the normal master.

The alternate arrangement is to open both sides of the line simultaneously to every contactor controlled from the master switch and from the control circuit limit switches. This system has been used in a few installations, and although we have furnished it in some of these cases, it complicates the design of the master switches and limit switches to an extent which I do not believe is justified.

The principal reason for opening both sides of the line to the control circuits is to prevent further travel in the "pour" direction when the master switch is reversed in case the control circuit of the "pour" directional switch becomes grounded. In other words, if this contactor does not open due to its operating coil being grounded and if the main line contactor in the other side of the line can be closed when the master switch is reversed, then the mixer would continue in the "pour" direction even if the master has been reversed. However, we control the main line contactor from two separate control wires from the master switch, one for the "pour" direction and one for the "return" direction, and these two wires are also electrically interlocked thru auxiliary contacts on the directional contactors; consequently, it is impossible for the mixer to continue in the same direction when the master is reversed, even if one of the directional contactors has failed to open.

Even if both sides of the line are opened to the control circuits on the master switch it does not necessarily follow that this would prevent operation in the same direction when the master switch is reversed; it would insure opening the directional contactor whose control circuit happened to be grounded, but when the master switch is reversed it is still possible that this ground would cause that directional contactor to close ahead of the one normally energized in the reverse direction, provided the latter contactor were a little more sluggish in closing, thereby allowing the grounded contactor to start closing first and compress the mechanical interlock which would result in the grounded contactor closing and holding out the other directional contactor.

It, therefore, seems to me that the 2-wire, electrically interlocked control of the main line contactor performs the main function that is expected of the system opening both sides of the line to all contactors, and does it in a much simpler and less expensive manner.

Operating and Maintaining High Voltage Lines and Equipment Safely

By A. N. CARTWRIGHT
Vice President, West Penn Power Company, Pittsburgh, Pa.

Presented before the A. I. & S. E. E. Annual Convention, June 20, 1932, Pittsburgh, Pa.

The problem of operating and maintaining high voltage equipment and overhead electric lines from the man safety standpoint is not unlike in principle from that of any other safety problem. It requires a thorough, full, and detailed knowledge of all of the hazards that make up the problem.

It is peculiar but nevertheless true, that the accident ordinarily occurs from what is commonly considered to be a non-hazardous situation. It is unusual that there is an absence of accidents from the normally considered more hazardous problem.

If we analyze these two facts, we come to the conclusion that care and attention to detail is the essence of working safely, for the problem that presents known hazard is very carefully thought out. It is checked and each situation fully covered and preventative action taken. The workmen themselves under this situation are highly alert during the process of the work because of its unusualness.

In the other case where situations are such that practically no hazard is apparent, the detailed checking may be either absent or loosely performed, and the workman goes into a situation in which he is either ignorant of hazard, or if a hazard is present and it is of apparently a minor nature, there is lack of concentration on the hazard because it is a minor hazard. This state of mind is prone to lead up to an accident.

It is therefore essential that there should be a well-thought-out and definitely laid down operating code or set of rules governing the working of men on high voltage lines and equipment. These rules should be adequate to cover all situations involved. The more simple any code or set of operating rules is, the more effective it will become, but simplicity must not be so emphasized that the plan fails to cover all conditions which may be encountered. The judgment of linemen and operators of smaller stations cannot be depended upon to interpret a complex code correctly under abnormal operating conditions unless these men are unusually well schooled. These rules should apply even before the lines or equipment are removed from service by requiring a full discussion among dispatchers, operators, and maintenance men of the job to be performed. With the taking of the lines out of service, the rules should definitely provide a procedure to assure that the lines taken out of service are those which are intended and necessary to take out of service; that proper precautions exist against their being energized while the men are still working upon them; that no unforeseen bad operating set-up will result; that when the time comes to reenergize the lines, that only those lines which it is proper to reenergize shall be again made alive; and that the men to do the work on these lines shall have full knowledge as to the lines which are deenergized and also of the lines which are to remain alive, if any, on the same structure on which they work.

A schematic record covering all of the facilities involved should be made, kept absolutely up-to-date, and be available for reference and study by all parties performing the switching operations or having charge of men working on the lines involved. Men doing the switching and the men doing the work on structures should be informed fully as to the extent of the effect of switching operations involving the lines affected.

An educational program under competent leadership should continually intensify the rigorous training of all men by reviewing the operating code, the changes made in the system plan or layout, and the developments of the operating and maintenance work. This educational program should include particularly employes who are doing work covered by the code only occasionally.

The design of line structures, if intended to be worked on when alive, should incorporate arrangement and clearances to allow the workmen to proceed with their duties when on the structure with the proper degree of safety. The design of the terminal switching point should include provision for grounding lines and blocking switches out of service. An additional safeguard commonly required is a visual opening of the circuit by disconnecting devices in addition to oil switches. Built-in ground facilities at the terminal points add to the ease of protecting the workmen and are advisable where lines are worked on at rather frequent intervals and when the speed at which the work must be done on the line is an item to be considered.

Rules Never to Be Violated

All switching operations involving the release of lines or facilities for men to work upon them should be handled by a competent man or men to dispatch all of the operations involved. This man or these men should have accurate and thorough knowledge of not only the schematic arrangement, but the physical arrangement of all of the facilities involved. With the knowledge of the problem ahead of him, he should have definitely indicated each operation and its sequence properly to take facilities out of service, and all steps should tie back to him.

Each order given by the dispatcher should be repeated back by the person taking the order and checked and O.K.'d before the operation is performed. If possible, the operator should be accompanied by a second party who has heard the order given, checked, and O.K.'d while he is proceeding with the switching operation as a check, in order that each operation is performed as it should be. If men are working on structures in which there is live equipment, the man in charge of this work will indicate to the dispatcher the exact location of this live equipment on the structure, indicating the direction in which he is facing when he is giving the location of the equipment.

An adequate tagging scheme should be developed and used conscientiously to mark all points where the line has been disconnected and grounded. If possible, tags should be prepared in advance to be ready to be placed at the proper points. This will speed up the operations as facilities should never be released for work until the tags are placed. These tags should be placed on the handles of the switches operated or in the eye of the hook disconnect switches to act as a check on the man reenergizing the line. They are also very necessary in the event of change of operators during the interim of work being done on the lines. The tags should carry the names of all parties who are in charge of work being done on the facilities released to them. The release should be accepted personally by the person obtaining it before he starts to work as this person should report clear of the release personally before service is restored on the lines.

Men in charge of work performed on grounded or metal structures should have adequate grounds placed on both sides of the point at which the men are to work, preferably within two sections of the point at which the work is to be done. This is to give protection against accidental contact of the conductors at some location along the route with energized conductors, or to prevent shock in case of error in switching and also to act as an adequate close drain of static electricity which is possible to be of such values as to shock a man sufficiently to cause him to release his hold upon the structure and fall, even though a line of some length may be grounded at the terminal. (There are certain situations where the wires have adequate insulation that such a procedure is not practical or desirable.)

All lines of 5000 volts and over should be grounded as indicated above whether on grounded or ungrounded structures. Grounding should be accomplished by the use of insulating sticks, live line clamps, and stranded cable. Chains should not be used for grounding because they are generally inadequate.

If linemen are adequately skilled and properly trained, they may work on lines up to 4000 volts when alive, provided they are properly equipped with rubber gloves, insulating blankets, rubber pigs, or similar devices, and are familiar with their safe use and are under proper direction. It is our practice to work on 25,000 volt lines when alive with the use of proper live line tools and by men who are thoroughly trained and directed in this work. Voltages up to 132,000 volts are worked on by some companies with the use of these tools as a standard procedure.

Inspection should be made to insure there being no attachments to structures of lines which are foreign to these normally carried on the structure and to assure that there is no proximity to line conductors which may be contacted with either by the men working on the structure or by the swinging of conductors caused by men working on the structures.

If wires are to be strung over working lines of hazardous voltage, clearance structures should be erected and the portion which supports the wire which is being strung should be grounded, and the heights should also be sufficient to insure against contact. If the wire being strung is bare and is being strung over or in the immediate vicinity of conductors or apparatus carrying dangerous voltages, adequate grounding during the stringing should be made at the reel or coil.

Where there is considerable work to be done in the vicinity of live equipment carrying dangerous voltages, a guard may be erected or a dead line by use of white tape may be established to prevent workmen approaching in too close proximity to the hazard. Where this is not feasible, a man whose sole duty shall be to act as guard should be placed in a position to watch and warn workmen on approaching too close to the energized equipment.

All of the above are basic requirements founded on the best thoughts of our Operating Department in many years of operating experience. Each situation requires a detail unto itself. Basically, this should cover any situation.

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ASSOCIATION NOTES

As a result of the recent election, the officers for the Chicago Section for the coming year are as follows:

Chairman—W. A. Perry, Superintendent, Power and Electrical Departments, Inland Steel Company, East Chicago, Ind.

Vice Chairman—K. E. Dinius, Electrical Department, South Works, Illinois Steel Company, South Chicago, Ill.

Secretary—A. J. Whitcomb, Assistant Electrical Engineer, Freyn Engineering Company, Chicago, Ill.

Executive Committeemen—C. J. Smith, Electrical Engineer, South Works, Illinois Steel Company, South Chicago, Ill.; G. E. Adams, Assistant Electrical Engineer, Indiana Harbor Works, Youngstown Sheet & Tube Company, East Chicago, Ind.; H. G. Hague, Chief Electrician, Sheet Mills, American Sheet & Tin Plate Company, Gary, Ind.

ITEMS OF INTEREST

PERSONNEL CHANGES

George G. Thorp on July 1 succeeded Eugene J. Buffington as president of the Illinois Steel Co. He was a vice president of the company since 1906. In 1892 he accepted the position of engineer of tests at the old North Works of Illinois Steel Co.. Mr. Thorp was transferred to Joliet works as assistant master mechanic, which position he left to become chief engineer for three years of the Colorado Fuel & Iron Co., Pueblo, Colo. Upon his return to the Illinois Steel Co., he was made general superintendent of the Joliet works.

His next move was to Pittsburgh, where he spent five years up to 1906, first installing and then operating the Clairton works for Carnegie Steel Co. He was then recalled to Chicago to become vice president of Illinois Steel Co., and also vice president of the Indiana Steel Co., which undertook the task of building the Gary works. From 1906 to the present time Mr. Thorp has thrown his energy into both the design and operation of this development. It is one of the largest steel-making plants in the country.

George Cook Kimball, who has been made vice president of the Illinois Steel Co., succeeding G. G. Thorp, has been vice president of the American Sheet & Tin Plate Co., Pittsburgh, in charge of plant construction, improvements, patents and similar matters, since September 15, 1931.

T. M. Rees, formerly with the Manning, Maxwell & Moore, Inc., Shaw Crane Division, has opened up an office in Pittsburgh, Pa. Mr. Rees will handle the Bryant Machinery & Engineering Company's product, which includes machine tools, welding equipment and general working machinery.

R. C. McDaniel resigned his position with the Keystone Lubricating Company and opened up a manufacturers' agency with headquarters at Parkersburg, W.Va.

T. B. McElray has been appointed superintendent of the Light and Power Departments of the Ohio Works, Carnegie Steel Company, Youngstown, O. Mr. McElray succeeds B. W. Gilson, who died April 27, 1932.

Al Proudfoot at Buffalo, N. Y., has entered into the manufacturers' agency field with headquarters at 587 Ellicott Square, Buffalo, N. Y.

R. W. Schuette, formerly with Treadwell Engineering Company, is now located with the Messinger Bearings, Inc., Pittsburgh, Pa.

C. Sam Swanson, 1616 Kresge Building, Detroit, Mich., has been appointed representative for The Ohio Electric Mfg. Co. of Cleveland, O., to sell their Fractional Size Electric Motors, 1/50 to 1 horsepower. G. R. Horne will continue to represent the Ohio company for the sale of their Lifting and Separation Magnets.

The Reliance Electric & Engineering Co., Cleveland, O., manufacturers of direct and alternating-current motors, have promoted R. H. Smith of the Boston office to manager of the Development Engineering Department with headquarters in Cleveland.

C. E. Robinson has been advanced to fill Mr. Smith's former position as manager of the Boston District office.

E. G. Gerber and Charles W. Lambert, formerly associated with the National Carbon Company, have purchased the Pittsburgh Brush Finishing Plant formerly operated by National Carbon Company and will continue the business in the same location, the Arrott Power Building, Pittsburgh, Pa., as the Diamond Carbon Company, manufacturing a complete line of brushes and welding carbon.

English & Lauer, Inc., 1224 South San Pedro Street, Los Angeles, have been appointed Southern California representatives of the American Air Filter Company, handling a complete line of air filtering and dust control equipment.

F. L. Lindemuth has been appointed chief engineer of the William B. Pollock Company, Youngstown, O., engineers, fabricators and erectors of steel construction of all kinds.

Mr. Lindemuth was formerly connected with the Mesta Machine Company, Perin & Marshall and the Colorado Fuel & Iron Company.

The Farval Corporation, 3277 East Eightieth Street, Cleveland, O., has recently acquired the manufacturing and sales rights of the Farval centralized system of lubrication. This equipment was formerly manufactured by Lubrication Devices, Inc., Battle Creek, Mich. The officials of the company include Howard Dingle, president; W. W. Clark, vice president; H. C. Robinson, treasurer; A. C. Blair, secretary. A. J. Jennings, formerly vice president of Lubrication Devices, Inc., is general sales manager of the Farval Corporation. The general sales and manufacturing facilities for the Farval lubrication system are now located at the Cleveland, O., address.

Announcement has been made of the appointment of E. F. Sells as manager of the Washington, D. C., office of the Westinghouse Electric & Manufacturing Company, to fill the vacancy caused by the recent death of B. H. Hamilton.

WITH THE MANUFACTURERS

The Timken Roller Bearing Company of Canton, O., is distributing a 12-page booklet entitled "An-

nouncing the Timken Wear and Lubrication Tester." This booklet, which is well illustrated, may be secured by writing the above company.

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The American Air Filter Co., Inc., Louisville, Ky., has prepared a 28-page booklet entitled "American Air Filter in Industry." This booklet contains many photographs, drawings and charts and interested parties may secure copies by writing the above concern.

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C. J. Tagliabue Mfg. Co. of Brooklyn, N. Y., has prepared the "Tag-Mono Indicator-Recorder Catalogue." These recorders are pictured and described and the methods of operation outlined in this catalogue. Copies may be secured by writing the above concern and requesting catalogue No. 1025.

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Reliance Electric & Engineering Co., Cleveland, O., now have ready for distribution bulletin No. 111 on Type AA Reliance Induction Motors Squirrel Cage and bulletin No. 112 on Fully Enclosed Fan Operated Reliance Induction Motors—Type AA Form F. These bulletins may be secured by writing the Reliance Electric & Manufacturing Company at Cleveland, Ohio.

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The New Departure Mfg. Company, Bristol, Conn., are distributing a very interesting booklet on "Lubrication of New Departure Bearings." The lubrication problem is handled very completely in this 12-page booklet. If interested in securing copies, write the above company.

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A new group of switches has been added to the Colt-Noark line of Meter Service Switches. The new switches take full advantage of the simplified service requirements of the 1931 Code, care for installations much more economically, and at the same time give complete satisfaction to both the public and the utilities on whose lines they are installed. Upon request a descriptive circular will be furnished by the Colt's Patent Fire Arms Mfg. Co., Hartford, Conn.

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Another Surface Combustion walking beam tinplate normalizing furnace has been purchased by the Bethlehem Steel Company at Sparrows Point, Md. The furnace is of the continuous walking beam type and will be equipped with high pressure automatic proportioning burners, and standard Surface Combustion hydraulic driving mechanism.

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A new Master Switch is being built by The Electric Controller & Mfg. Co., Cleveland, O. This Master Switch, known as the Type NX Master Switch, the function of which is to regulate the control circuits of a magnetic controller, is designed for use where a maximum of three points of speed control in either direction is required.

Applications for which the Type NX Master is particularly well suited include Roller Tables and other steel mill drives, Bridge and Trolley Motions of small cranes where not more than three points of speed control are required, and for small Hoists equipped with the Wright Dynamic Lowering Circuit Magnetic Controller.

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OBITUARIES

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Julian Kennedy, engineer, inventor and a leading authority on blast furnace and steel plant construction, died at his home in Pittsburgh on May 28.

Mr. Kennedy was born in Poland, Mahoning county, O., March 15, 1852. He was educated at Yale's Sheffield Scientific School, where he graduated in 1875.

Before going to Yale Mr. Kennedy had been a draftsman under his father in the construction of the Struthers Iron Company. He was an instructor of physics at the Sheffield school in 1876; superintendent of the Brier Hill Iron Company blast furnaces, 1876-77; superintendent of the Morse Bridge Works, 1877-78; blast furnace superintendent of the Edgar Thomson Steel Works, 1879 to 1883; blast furnace superintendent, Lucy Furnaces, 1883 to 1885; general superintendent, Carnegie, Phipps & Co., Homestead, 1885 to 1888, and chief engineer, Latrobe Steel Works, 1888 to 1890, when he became a consulting engineer.

Mr. Kennedy, as a consulting engineer, was connected with many important steel concerns in America and abroad, having done a large amount of work in Russia and India. He had many patents in connection with the manufacture of iron and steel products.

He had received many awards, and on May 19, last, he received the Gary medal for outstanding achievement in chemical and metallurgical advancement of the iron and steel industry from the American Iron and Steel Institute.

Mr. Kennedy was a member of the American Iron and Steel Institute and the British Iron and Steel Institute. He was a valued member of the Association of Iron and Steel Electrical Engineers, joining our organization in March, 1913.

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A. L. Cromlish, general superintendent of the Duquesne Plant, Carnegie Steel Company, died June 9.

Mr. Cromlish was a graduate of Penn State College in 1897. On leaving college, he entered the Chemical Laboratory of the Shenango Valley Steel Company at New Castle, Pa. After two years he became chemist for the Carnegie Company at Niles, O., subsequently he was associated with the Carnegie Company at Farrell, Donora and City Furnaces, finally becoming general superintendent of the Farrell Works in 1920, and where he remained until 1931, at which time he became general superintendent of the Duquesne Works of the Carnegie Steel Company in May, 1931.

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Robert Baird Williamson, electrical engineer and for 27 years a member of the engineering staff of Allis-Chalmers Mfg. Co., died at his home in Milwaukee on June 26.

Since 1910 Mr. Williamson has had charge of the design of all alternating current rotating machinery built by Allis-Chalmers.